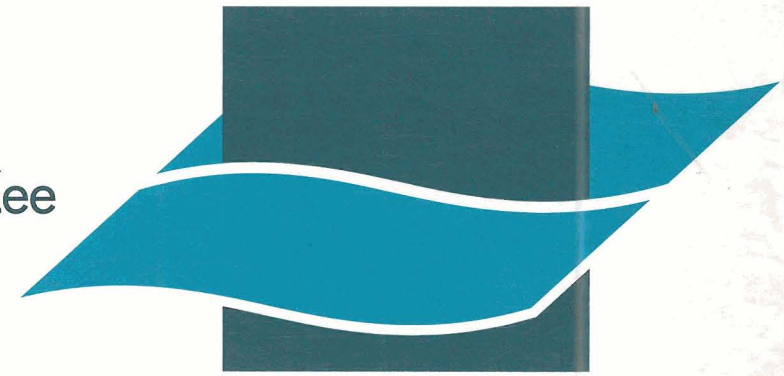
Vlaams Instituut voor de Zee



Book of abstracts

VLIZ Young Scientists' Day

Brugge, Belgium
23 February 2001

VLIZ Special Publication 1
2001

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VLIZ Young Scientists' Day

Brugge, Belgium
23 February 2001

Flanders Marine Institute (VLIZ)
Oostende, Belgium

VLIZ Special Publication 1
2001

Preface

The Flanders Marine Institute (VLIZ) supports marine scientific research in Flanders. VLIZ offers logistic support, promotes expertise internationally, and serves as an interface between the scientific community, governmental bodies, and the public at large. VLIZ wants to give exposure to marine, coastal and estuarine research in Flanders, whereby coordination and dissemination of information play key roles.

Marine research in Flanders is carried out by the six Flemish universities, research institutes and departments of the Flemish and federal authorities, and to a lesser extent by private enterprises. The major broad disciplines covered are: biology, earth sciences, chemistry, physics, aquaculture and fisheries, engineering, and maritime affairs. Annually, VLIZ bundles the scientific contributions of the Flemish marine researchers in the 'VLIZ Collected Reprints'.

VLIZ increases the visibility of marine research in Flanders by producing publications, organizing symposia and granting scientific awards. On Friday 23 February, 2001 the first annual 'Young Scientists' Day' was organized in conjunction with the VLIZ General Assembly in Provinciehuis Boeverbos, Sint-Andries (Brugge), Belgium.

The laureates of the VLIZ scientific awards for the year 2000 presented their research and a poster competition for young scientists was held.

This 'VLIZ Special publication 1' comprises the abstracts of these oral and poster presentations.

Dr. Jan Mees, Director VLIZ

Table of Contents

VLIZ aanmoedigingsprijzen mariene wetenschappen 2000

Jaarlijks kent het Vlaams Instituut voor de Zee (VLIZ) twee prijzen toe ter bekroning van twee afstudeerwerken (universitaire tweede cyclus of HOBU lange type). Zowel fundamentele als toegepaste onderzoeksonderwerpen in alle takken van de mariene wetenschappen komen in aanmerking. De prijzen bedragen elk 500 EUR (~20.000 BEF) en zijn voorbehouden aan jonge onderzoekers die ten hoogste twee jaar afgestudeerd zijn aan een Vlaamse universiteit of hogeschool.

De aanmoedigingsprijzen 2000 werden ex aequo toegekend aan:

Mevrouw Chantal Martens voor het werk getiteld:

Morfo- en sedimentdynamiek van de kustnabije zone te Egmond-aan-Zee (Nederland)

Mevrouw Véronique Vanquickelberghe voor het werk getiteld:

Biodiversiteit van het hyperbenthos langs een dieptegradiënt (200 tot 700m) op de continentale helling

Chantal Martens

UNIVERSITEIT
GENT

Faculteit Wetenschappen
Vakgroep Geologie en Bodemkunde

Morfo- en sedimentdynamiek van de kustnabije zone te Egmond-aan-Zee (Nederland)

Chantal Martens

Academiejaar 1998-1999

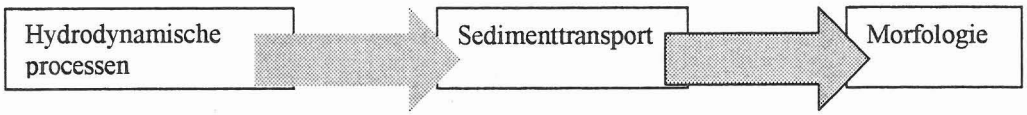
Scriptie voorgelegd voor het verkrijgen van het diploma van licentiaat in de Geologie

Promotor: Prof. Dr. P. Jacobs
Co-promotor: Prof. Dr. J. Lanckneus
Leescommissie: Prof. Dr. J.-P. Henriet, Prof. Dr. P. De Paepe

Morfo- en sedimentdynamiek van de kustnabije zone te Egmond-aan-Zee (Chantal Martens)

1.Inleiding

Evoluties van kusten kunnen samengevat worden in een betrekkelijk eenvoudig schema (figuur 1) : hydrodynamische processen induceren een sedimenttransport, dat op zijn beurt leidt tot veranderingen in de morfologie van de kust. Deze veranderingen in de morfologie gebeuren niet altijd direct en ook niet altijd op dezelfde schaal (zowel in tijd als in ruimte). Het systeem is met andere woorden niet vaak in evenwicht. Het is dus bijzonder belangrijk te kunnen weten hoe een kust zal evolueren, met of zonder menselijk ingrijpen in die evolutie.



Figuur 1: verband tussen de hydrodynamische processen, sedimenttransport en morfologie van een gebied.

Kusten kunnen opgedeeld worden in drie verschillende categorieën: 2D kusten (gelijkvormig over de hele oppervlakte) , 2.5D (zoals 2D, maar met bepaalde non-conformiteiten zoals rip channels) en 3D kusten (met een volkomen onregelmatig profiel) . Een van de beste methodes om inzicht te krijgen in de manier waarop deze kusten evolueren en zich aanpassen aan de veranderende omstandigheden is het toepassen van numerieke modellen, die de structuur, organisatie en het functioneren van de kust simuleren. Deze numerieke modellen worden echter niet systematisch getest met velddata zodat ze puur theoretisch blijven, bovendien zijn de modellen vaak alleen maar toepasbaar op 2D kusten (wat een niet echt reële situatie is) en dan nog meestal ontwikkeld voor Noordamerikaanse kusten, die sterk kunnen verschillen van de Europese.
Deze thesis steunt op gegevens verzameld in het kader van het COAST3D project. Het COAST3D project maakt deel uit van het MASTIII programma (Marine Science and Technology) en zijn doel is viervoudig:

- tot een beter begrip komen van de fysische processen van zandtransport en morfologie in kustomgevingen;
- het verkrijgen van meer data (ivm zandtransport en morfologie) om numerieke modellen voor de analyse van kustprocessen te testen;
- het testen van een representatief aantal numerieke modellen met de verkregen data;
- het verkrijgen van geteste modellen die inzetbaar zijn bij het beheer van kusten.

Om dit te verwezenlijken worden metingen uitgevoerd, bedoeld om de numerieke modellen te testen en dit onder condities die typisch zijn voor Europese kustgebieden.

In deze thesis worden resultaten verwerkt die afkomstig zijn uit het eerste deel van de metingen die plaatsgrepen in Egmond-aan-Zee (NL) . De kust in Egmond-aan-Zee is van het 2.5D type en is een typevoorbeeld van de zandige kusten met kustparallelle banken (zie figuur 2 voor een overzicht van het gebied) : in het onderzoeksgebied bevinden zich twee kustparallelle banken, gescheiden door een trog.

Op zee werden langs zes raaien in totaal 60 stalen genomen; langs het strand 56 staen langs drie raaien. De korrelgroottekurves van deze stalen werden bepaald met een laserdiffractometer en de valbuis van de Universiteit Utrecht.
De resultaten van deze analyses werden verwerkt en gebruikt om de residuele transportpaden van het sediment in het onderzoeksgebied te bepalen. Er werd geopteerd voor het gebruik van de methode van Gao & Collins (1992, 1994) bij het bepalen van de residuele transportpaden, wat meteen een test was voor de methode in de zeer kustnabije zone.
Het gebied werd ook met behulp van side scan sonar in beeld gebracht, met de bedoeling uit de asymmetrie van de sedimentaire structuren eveneens residuele transportpaden te bepalen. Niettegenstaande de sonarbeelden een prachtig beeld geven van de morfologie van de kustnabije zone komen er te weinig asymmetrische ribbels voor om genoeg gefundeerde transportpaden af te leiden. De morfologie werd wel schematisch in kaart gebracht en de sequenties werden vergeleken met voorbeelden van bank/trog systemen uit de literatuur en met de gegevens over o.a. stroomsnelheid uit de modellen.

2.Verwerking van de gegevens

A.Verwerking van de sedimentstalen

De granulometrische eigenschappen van de sedimentstalen werden zowel ontkalkt als niet-ontkalkt met de laserdiffractometer en de valbuis van de universiteit Utrecht geanalyseerd.
De residuele transportpaden in het gebied (strand en zee apart) werden dan bepaald met behulp van de methode van Gao en Collins.
Deze methode steunt op de veranderingen van de granulometrische parameters van de sedimenten. De volgende parameters worden gebruikt:

- mean : de gemiddelde korrelgrootte van het sediment;
- skewness : de skewness drukt uit of het sediment dan wel een grof sediment is met een overmaat aan fijn materiaal (positieve skewness) dan wel een fijn sediment met een overmaat aan grover materiaal (negatieve skewness) ;
- sortering: drukt uit hoe goed het sediment gesorteerd is.

Deze parameters worden tussen de sedimentstalen onderling vergeleken en er wordt gezocht naar het voorkomen van bepaalde trends (bvb: FB-: Finer, better sorted, more negative skewness) die een transportrichting zouden kunnen aanduiden. Na het elimineren van de ruis kunnen deze trends per staal opgeteld en voorgesteld worden. De meest gebruikelijke voorstelling is deze die vectoren gebruikt: voor elk staal wordt een vector getekend waarvan de hoek de richting van de trend aangeeft en de lengte de betrouwbaarheid van de trend.
De op het strand genomen stalen gaven na analyse een aanduiding van landwaarts transport.
Voor de analyse van de in zee genomen stalen werd een fortran programma gebruikt (Gao, 1996) en de resultaten kunnen gezien worden in figuur 3.
Op de figuur kunnen drie transporttrends onderscheiden worden:

- een muistroom (snelle zeewaartse stroming over een beperkt gebied) die duidelijk een kanaal gevormd heeft in de binnenste bank. Ook de zogenaamde feeder currents die de kustparallelle aanvoer naar de muistroom toe bepalen zijn goed zichtbaar in de trog voor de binnenbank;
- een tweede transport is het NE waarts gerichte transport over de buitenste bank. Dit transport is meest waarschijnlijk veroorzaakt door de asymmetrie van de getijstromingen voor de kust;
- een derde zuidwaarts gericht kustparallel transport is merkbaar bij de binnenbank en dichtbij het strand: naar alle waarschijnlijkheid is dat het kustparallel transport veroorzaakt door de golven. De golven breken op de flank van de binnenste bank en veroorzaken daardoor een kustparallelle stroming.

Bij deze hele interpretatie moet ook rekening gehouden worden met de meteorologische effecten: de periode vóór het veldwerk werd gekenmerkt door zware en aanhoudende stormen. Deze hebben natuurlijk hun invloed op het sedimenttransport. Zo kan het bijvoorbeeld ook zijn dat het zeewaarts transport de uitdrukking is van een stormgeïnduceerd zeewaarts transport in plaats van de muistroom. Dit transport zou dan gebruik gemaakt hebben van de morfologie die reeds gecreëerd was door de muistroom. De side scan sonar beelden (zie punt b) bevestigen het massale zeewaartse transport.

Vergelijkingen met Delft3D modelleerresultaten uitgevoerd door de universiteit Utrecht voor hetzelfde gebied bevestigen de hypotheses.

B. Verwerking van de side-scan sonar opnames

Uitgaande van de side scan opnames werd de morfologie van het gebied schematisch in kaart gebracht en vergeleken met reeds bestaande analyses van vergelijkbare gebieden. (zie figuur 4)
Vier grote gebieden kunnen onderscheiden worden:
-schijnbaar effen gebieden zonder duidelijke structuren;
-lunate megaribbels;
-symmetrische ribbels;
-een gebied met effen gebieden, lunate megaribbels en assymetrische ribbels door elkaar.

De kenmerkende omstandigheden qua waterdiepte en stroomsnelheid nodig voor het ontstaan van deze structuren kunnen een indicatie geven over het hydrodynamische regime van het gebied.

De rip channel vertoont zeewaarts gericht lunate ribbels en ook assymetrische ribbels die een zeewaarts transport lijken aan te duiden. Verder vertoont deze rip channel nog een plane bed (een effen oppervlak van sedimenten

dat onder bepaalde voorwaarden voor stroomsnelheid en korrelgrootte gevormd wordt) dat verderloopt in de achterliggende trog (die naast het plane bed ook symmetrische ribbels vertoont) .
De kans bestaat dat het plane bed geen echt plane bed is, maar eerder veroorzaakt werd door massale sedimentafzettingen tijdens de storm die het veldwerk voorafging. Het mogelijke bewijs dat dit transport het gevolg is van de storm (eerder dan van de muistroom) wordt gegeven door de scherpe grenzen tussen de symmetrische ribbels en de relatief vlakke afzettingen (de zgn. plane beds) in de trog. Deze scherpe grenzen wijzen erop dat de vlakke sedimentafzetting boven op het normale sedimentpatroon (symmetrische ribbels) werd afgezet. De nep plane beds zouden dus een relict van de storm kunnen zijn terwijl de lunate structuren in de rip channel er op wijzen dat de muistroom weer actief is.
De binnenbank is wegens de geringe diepte niet goed zichtbaar op de side scan beelden, maar de effen structuur laat vermoeden dat het breken van de golven op binnen- en buitenflank een plane bed gecreëerd heeft.
De binnenflank van de buitenbank van zijn kant vertoont een chaotisch mengsel van plane beds, assymetrische ribbels en lunate megaribbels. De oorzaak kan gezocht worden in afschuivingen (de flank is betrekkelijk stijl) of in het ondieper worden van de golven die -naargelang de omstandigheden- al dan niet breken.
De buitenflank en top van de buitenbank worden gekenmerkt door een opeenvolging van golf- en stroomribbels en landwaarts gerichte lunate megaribbels. Deze morfologie zou kunnen veroorzaakt zijn door stroming die zijn oorsprong vindt in de stijgende asymmetrie van de golven die in ondieper gebied terechtkomen.

De resultaten van het Delft3D model dat uitgevoerd werd door de universiteit Utrecht voor dit gebied bevestigen deze hypotheses.

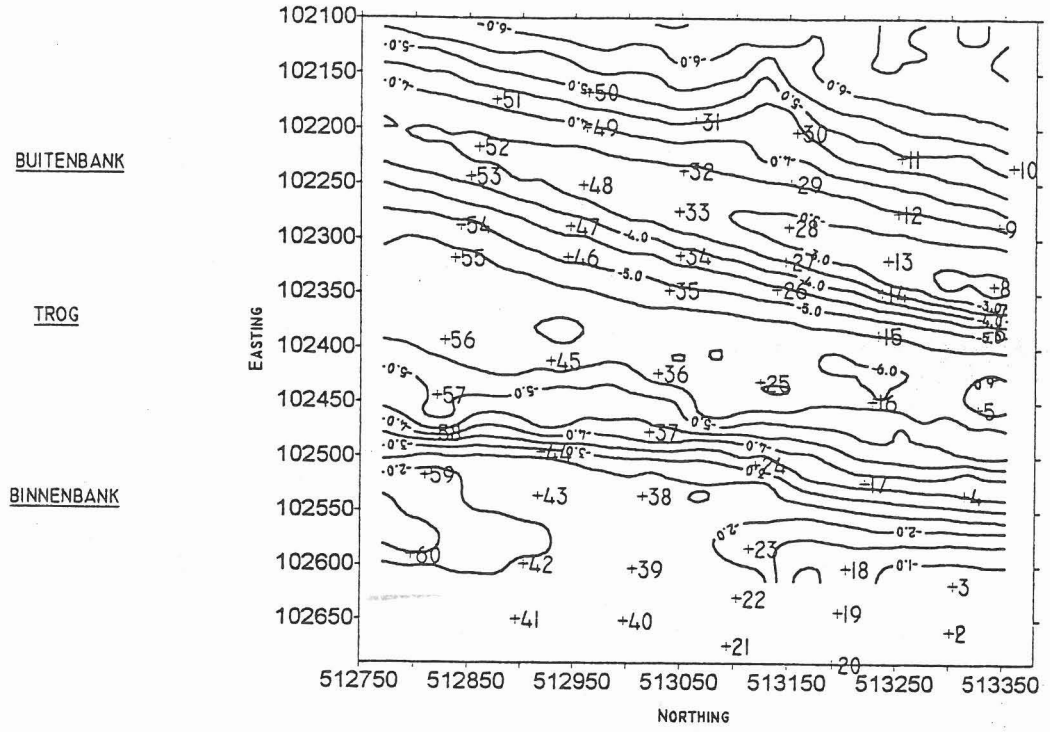
3. Besluit

Uit de resultaten van de korrelgrootteanalyse en de side scan beelden kunnen twee sedimentatie-omgevingen geschetst worden in het gebied: een situatie met "normale" meteorologische condities en een dor storm gedomineerde situatie.

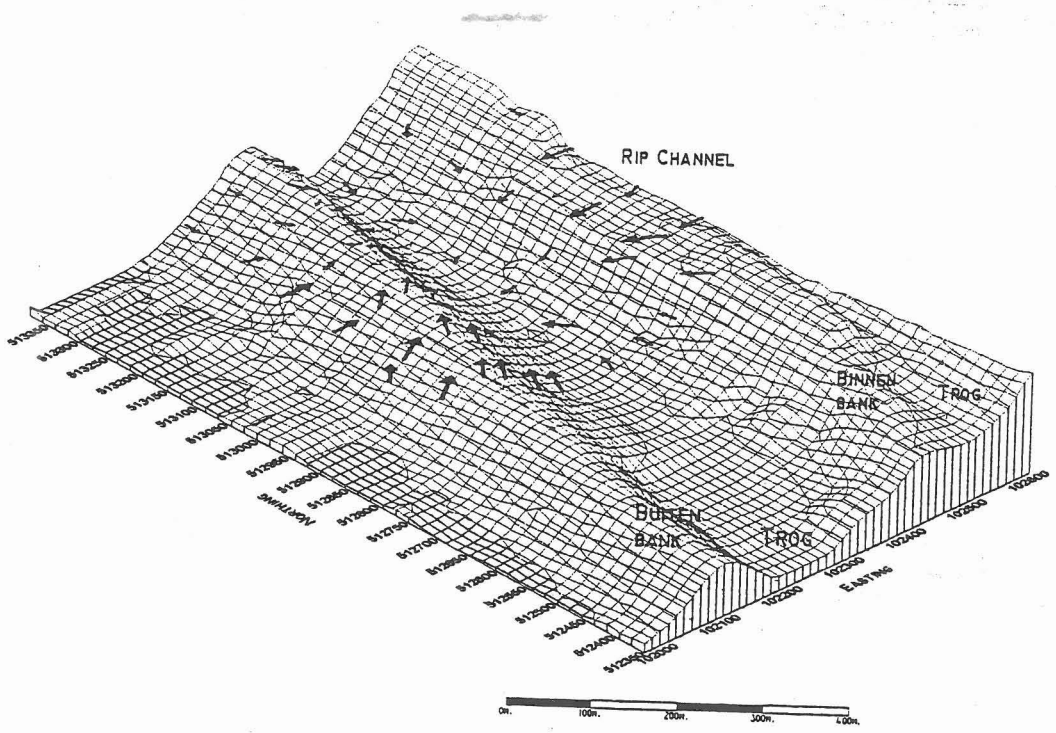
a. De sedimentaire omgeving tijdens niet-storm condities
Tijdens de niet-storm condities heerst over de buitenbank en de trog een residueel noordwaarts transport, geïnduceerd door het getij. Eventueel kunnen enkele golven reeds instabiel worden of beginnen breken op de buitenbank. De omgeving is echter meestal te diep om de golven volledig te laten breken, en eenmaal ze over de top van de buitenbank zijn herstellen ze zich weer. Deze golven veroorzaken de betrekkelijk symmetrische golfribbels in de trog tussen binnen- en buitenbank.
Eenmaal de golven bij de flank van de binnenbank zijn aangekomen, beginnen ze te breken en veroorzaken een kustparallelle stroming achter de bank. Er vormt zich een muistroom, met een rip channel in de binnenbank, waarin sediment offshore wordt getransporteerd.

b. De sedimentaire omgeving tijdens stormcondities.

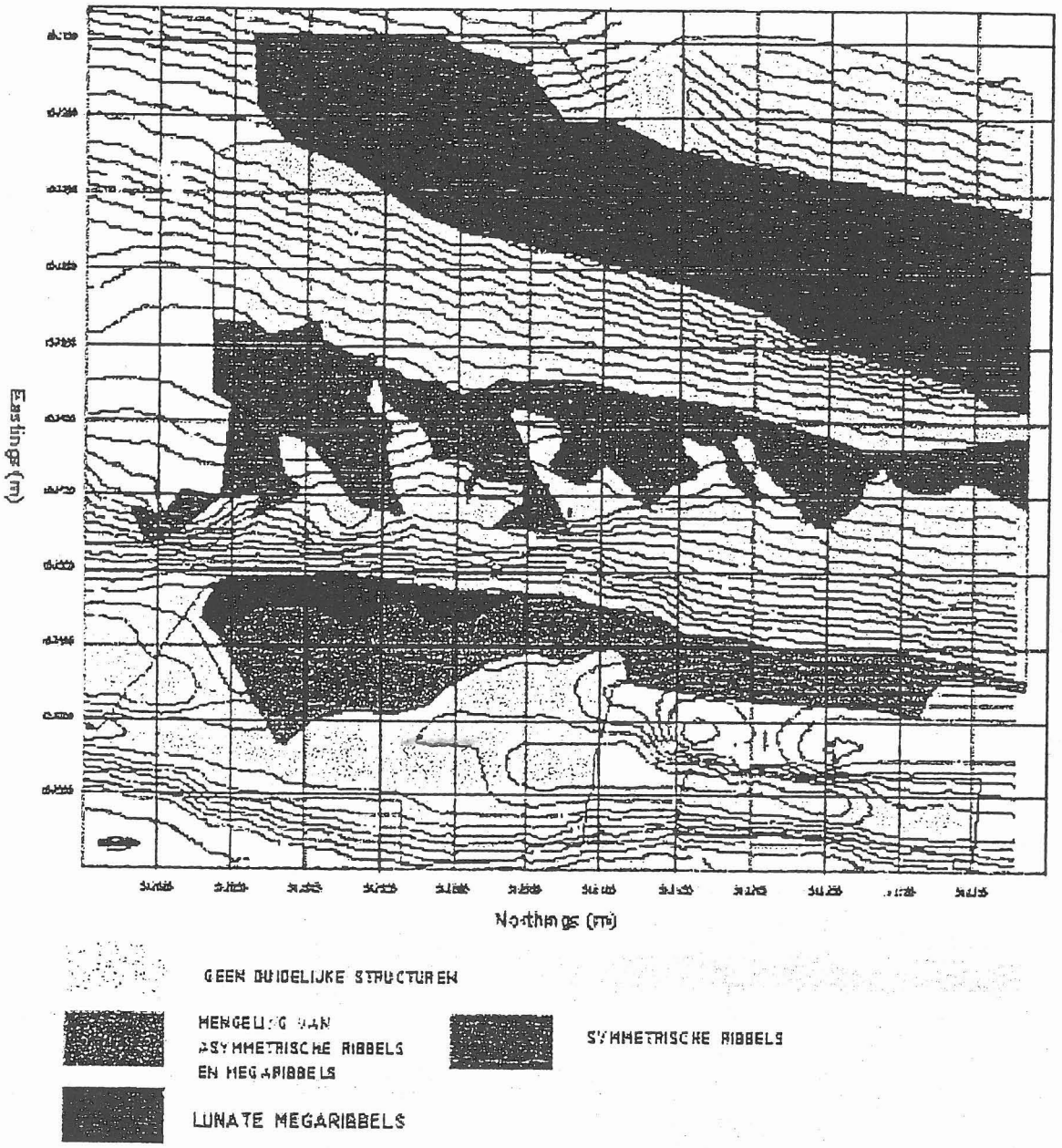
Tijdens stormcondities is het waarschijnlijk dat de golven al beginnen breken en grotere instabiliteit vertonen op de buitenbank. Dit leidt tot en vergrote hoeveelheid sediment die in suspensie gebracht wordt en getransporteerd kan worden.
Vanaf het strand worden grote hoeveelheden sediment geërodeerd en zeewaarts getransporteerd kan worden.
Vanaf het strand worden grote hoeveelheden sediment geërodeerd en zeewaarts getransporteerd. Dit transport maakt waarschijnlijk gebruik van de aanwezige morfologie (de rip channel in de binnenbank) om het sediment zeewaarts te transporteren. Gezien de grote hoeveelheden sediment die in transport zijn wordt een groot deel onmiddellijk weer afgezet in de trog tussen de binnen- en buitenbank.
Enkele golven kunnen nog breken op de binnen bank en eventueel een kustparallelle stroming induceren; het dominante transport is toch zeewaarts gericht.



Figuur 2 : overzicht van de bathymetrie van het onderzoeksgebied. De in zee genomen stalen zijn eveneens aangeduid.



Figuur 3: 3D zicht op de residuele transportpaden in het onderzoeksgebied.



Figuur 4 : schematisch overzicht van de voorkomende sedimentaire structuren in het onderzoeksgebied.

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ACADEMIEJAAR 1998 - 1999

Biodiversiteit van het hyperbenthos langs een dieptegradiënt (200 tot 700 m) op de continentale helling.

door

Véronique Vanquickelberghe

Promotor: Prof. Dr. Magda Vincx
Begeleider: Ann Dewicke

Scriptie voorgelegd tot het behalen van de graad van Licentiaat in de Biologie (richting dierkunde)

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Biodiversiteit van het hyperbenthos langs een dieptegradiënt (200 tot 700 m) op de continentale helling.

door Véronique Vanquickelberghe

Samenvatting

Continentale hellingen vormen één van de belangrijkste topografische eenheden op aarde. De structuur van de faunasamenstelling op de continentale helling in verschillende geografische gebieden wordt grotendeels bepaald door ruimtelijke verschillen in omgevingsvariabelen en lokale oceanografische condities met in het bijzonder de diepte, het bodemtype en de eigenschappen van de watermassa's (Moranta *et al.*, 1998).

De continentale helling in deze studie, is gesitueerd tussen 47° 59.53' en 47° 44.79' NB en 7° 47.94' en 8° 1.43' WL in de noord-oostelijke Atlantische Oceaan ter hoogte van de Golf van Biscaye. Dit gebied draagt de naam Eperon Berthois en werd tot voorheen nog niet bestudeerd. Het doel van dit onderzoek is een beschrijving te geven van de samenstelling, de bathymetrische distributie en de biodiversiteit op verschillende taxonomische niveaus van het hyperbenthaal langsheen een dieptegradiënt van 200 tot 700 m op de bestudeerde continentale helling.

Tijdens de staalname van september 1995 werd een transect van zes stations bemonsterd met een hyperbenthische slede met maaswijdtes van 1 mm en 0.5 mm (Sorbe, 1983) langsheen de dieptegradiënt waarbij het diepteverschil tussen twee stations telkens ongeveer 50 meter bedroeg. Enkel de zone tussen 300 en 600 meter werd niet bemonsterd, deze zone was ontoegankelijk door visserijactiviteiten. Per sleep werden een aantal omgevingsvariabelen gemeten (temperatuur, saliniteit, turbiditeit en concentratie opgeloste zuurstof) en werd een bodemstaal genomen voor sedimentanalyse. Alle organismen (van de 1 mm stalen) werden gedetermineerd tot op soortsniveau, geteld en de densiteiten en biomassa's werden berekend. Na de exploratie van de datamatrices werd de aandacht hoofdzakelijk gericht op de distributiepatronen en de biodiversiteit van taxonomische groepen en soorten

langsheen het transect. Teneinde de verschillende aspecten van biodiversiteit zo goed mogelijk te benadrukken werden talrijke verschillende methodes gehanteerd.

In de 6 stalen werden 25515 individuen gevangen, behorende tot 220 hyperbenthische soorten. De gemiddelde densiteit en biomassa van de totale dataset bedroegen resp. 802 N/100m² en 412.5 mgADW/100m². Vooral de peracaride Crustacea hadden veel vertegenwoordigers in het hyperbenthaal: 84 soorten Amphipoda, 23 soorten Mysidacea, 21 soorten Isopoda, 16 soorten Cumacea en 3 soorten Tanaidacea. Van de overige taxa waren de Copepoda en de Decapoda belangrijk met resp. 29 en 20 soorten. De Euphausiacea, Pisces, Pycnogonida, Chaetognatha, Mollusca en Leptostraca vertegenwoordigden elk minder dan 8 soorten. De belangrijkste taxonomische groepen voor zowel de densiteit en de biomassa waren de Amphipoda (307 N/100m² en 147 mgADW/100m²), de Cumacea (205 N/100m² en 128 mgADW/100m²) en de Mysidacea (147 N/100m² en 95 mgADW/100m²).

Studie van de biodiversiteit langsheen de gradiënt bracht duidelijke verschillen tussen de ondiepe (ch200, ch250 en ch300) en de diepe (ch600, ch650 en ch700) stations aan het licht. Wat betreft de soortensamenstelling waren de stations zeer divers en traden er ook hier sterke veranderingen op langsheen de gradiënt. Het gemiddeld aantal soorten, de gemiddelde densiteit en de gemiddelde biomassa lagen voor de diepe stations steeds hoger in vergelijking met de ondiepe stations. Voor de ondiepe stations bedroegen deze waarden resp. 72 soorten, 647 N/100m² en 281.2 mgADW/100m² in tegenstelling tot de respectievelijke waarden voor de diepe stations nl. 101 soorten, 959 N/100m² en 543.8 mgADW/100m². Er trad ook een zeer opvallende shift op in het voorkomen van bepaalde taxa en hun aandeel. In de ondiepe stations waren de Mysidacea (gemiddeld 214 N/100m² voor de drie ondiepe stations) en de Euphausiacea (gemiddeld 117 N/100m²) belangrijke taxa. Een aantal taxa waren belangrijker qua densiteit in de drie diepere stations, met name de Amphipoda (gemiddeld 433 N/100m² voor de drie diepe stations), de Cumacea (gemiddeld 308 N/100m²) en de Isopoda (gemiddeld 126 N/100m²). Ook de Tanaidacea en de Pycnogonida kwamen uitsluitend voor in de diepere stations maar waren qua densiteiten minder belangrijk. Binnen de verschillende taxa traden ook duidelijke verschuivingen op van de genera en de soorten langs de dieptegradiënt. Er was een sterker dominantie-effect voor de ondiepe stations. De hogere diversiteit voor de

diepe stations in vergelijking met de drie ondiepe stations werd ook weerspiegeld in de diversiteitsindices van Hill, de 'expected number of species' (ES(100)) en de k-dominantiecurves. De drie diepe stations vertoonden onderling meer gelijkenis dan de drie ondiepe stations onderling. Dit bleek uit de similariteiten en de k-dominantiecurves.

Naast een studie van de patronen in biodiversiteit langsheen de dieptegradiënt werd ook een vergelijkende studie uitgevoerd met andere diepe gebieden evenals met ondiepe gebieden. Onderzoeksdata van andere diep gelegen gebieden, samen met de diepteranges van belangrijke peracaride genera werden samengevat in tabellen. De vergelijkende studie met ondiepe gebieden richtte zich op het hyperbenthos van het Belgisch continentaal plat (BCP), het Friese front en de Doggerbank. De continentale helling uit deze studie vertoonde in vergelijking met de meer ondiepe gebieden een hoge soortenrijkdom.

Algemeen kan worden besloten dat het hyperbenthos in het bestudeerde gebied zeer divers was en dat er een aantal duidelijk verschillen waren tussen de ondieper gelegen stations (ch200, ch250 en ch300) en de diepe stations (ch600, ch650 en ch700). Langsheen het transect namen zowel densiteiten, biomassa's als biodiversiteit toe met de diepte. Bepaalde taxonomische groepen zoals Isopoda, Cumacea en Tanaidacea werden belangrijker op grotere diepte, terwijl de Mysidacea en de Euphausiacea meer aangetroffen werden in de ondiepe stations.

Referenties

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Annual VLIZ North Sea Award - 2000

On the initiative of Bart Schiltz, President of the Belgian Fish Producers Organization, the Flanders Marine Institute (VLIZ) awards a scientific prize to foster innovative fundamental or applied research on the structure and functioning of the North Sea ecosystem, with emphasis on coastal and estuarine areas of the Southern Bight and the Channel. The prize is awarded to a researcher (or a research team) working and residing in a country bordering the North Sea. The prize amounts to 1000 EUR and is indivisible. It is granted to reward a recent original scientific contribution, preferably having relevance to the sustainable management of the area concerned. Studies pertaining to the biodiversity of the local ecosystem are equally welcomed. The contribution has to be of postgraduate or postdoctoral level.

The Annual VLIZ North Sea Award 2000 is awarded to:

Dr. Johan Craeymeersch

for his scientific contribution entitled:

Distribution of macrofauna in relation to the micro-distribution of trawling effort

Johan Craeymeersch

Distribution of macrofauna in relation to the micro-distribution of trawling effort

Craeymeersch Johan

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This study focusses on the impact of beam trawling on the Dutch Continental Shelf. As the gears scrape the surface, trawling causes mortality in target and non-target species. Direct mortality due to trawling occurs both among the caught and subsequently discarded animals as in the trawl path, among animals that are damaged or killed by the passing gear. Thus, evidence is available of the direct effects of beam trawling (Collie *et al.* 1997, Jennings and Kaiser 1998, Lindeboom and de Groot 1998) The longer term effects of demersal fisheries on benthic marine ecosystems are still a point of discussion. The long-term impact on a particular species will depend on the direct mortality at each fishing event, the distribution of the fishing effort, the distribution of that species and its life history characteristics such as longevity and fecundity. The longer-term effects may be evaluated from long term trends in benthos or by-catch data. They may also be inferred from comparisons between fished and un-fished areas. The detailed information of fishing effort that recently became available (Rijnsdorp *et al.* 1998) offered the opportunity to compare benthic fauna of areas under different levels of fishing disturbance. Previously, information on fishing activities was limited to a scale of approximately 30 by 30 nautical miles. The information was derived from automated position registration systems. The study focussed on two subareas on the Dutch Continental Shelf. The subareas are, among others, based on the known differences in the distribution of benthic animals in the North Sea. The data on the macrobenthic fauna comes from a detailed survey in the period 1985-1990 and presented in an atlas (Holtmann *et al.*, 1996).

A direct gradient analysis pointed to a globally significant difference in species composition between intensively fished and less heavily fished locations. It is, however, very likely that a major part of these differences are not related to differences in trawling effort but to differences in environmental factors. On the contrary, differences in spionid densities are most likely explained by differences in fishing effort. The total density of spionids, mostly opportunistic species, increased with increased fishing disturbance.

CURRICULUM VITAE

Identiteit

Naam: CRAEYMEERSCH, Johan Achiel Marcel

Studies

Middelbare studies: Latijn-Wiskunde, St.-Janscollege, Hoegaarden, België

Hogere studies:

1. - Periode: 1978-1983
   - Instelling: Rijksuniversiteit Gent, België
   - Studierichting: Licentiaat in de Wetenschappen, groep Dierkunde
   Keuzevak: Inleiding tot de mariene biologie
   Stages: Cursus limnologie te Besse, Frankrijk (21-26 mei 1982).
   Cursus mariene biologie te Texel, Nederland (2-10 juli 1982).
   Cursus mariene biologie te Roscoff, Frankrijk (5 augustus - 3 september 1982).
   Cursus mariene biologie te Wimereux, Frankrijk (15-22 september 1982).
   Licentiaatsthesis: "De produktie van *Mytilus edulis* L. (Mollusca-Bivalvia) op de Slikken van Vianen (Oosterschelde - Nl)"

2. - Periode: 1985-1989
   - Instelling: Instituut voor Zeewetenschappelijk Onderzoek (sekretariaat), Oostende, België
   - Studierichting: Interuniversitaire Derde Cyclus Mariene Ecologie
   Keuzevakken: statistische verwerking van biologische gegevens; sedimentologie; oceanologie; interakties water-sediment; plankton; benthos; ecologische modellen; estuaria.

3. - Periode: 20 augustus - 7 september 1990
   - Instelling: European Institute for Advanced Studies in Oceanography (E.I.A.S.O.) (gastheer: The School of Marine Sciences, University College, Galway).
   - Studierichting: "The structure and dynamics of shelf benthos" (post-graduate course).

Promotie:
Academiejaar 1998-1999. Rijksuniversiteit Gent. Titel proefschrift: The use of macrobenthic communities in the evaluation of environmental change.

Funkties

16.12.85 - 15.02.86 : Onderzoeker verbonden aan de Rijksuniversiteit Gent, Instituut voor Dierkunde, Sektie Mariene Biologie.
Taken: een analyse van 15 jaar onderzoek naar de dichtheid, biomassa, produktie en trofische relaties van het macrobenthos in de Zuidelijke Bocht van de Noordzee; een analyse van macrobenthosgegevens Westerschelde.

01-08-86 - 14.02.91 : Onderzoeker verbonden aan het Delta Instituut voor Hydrobiologisch Onderzoek, Yerseke.
Taken: onderzoek naar de invloed van de bouw van de stormvloedkering op het macrobenthos in de Oosterschelde en de Voordelta;

monitoring van het macrobenthos in de Haringvlietmonding.

01-06-91 – 15.07.98 : Onderzoeker verbonden aan het Nederlands Instituut voor Oecologisch Onderzoek, Centrum voor Estuariene en Mariene Oecologie, Yerseke. Taken: monitoringsonderzoek benthos in Deltagebied en Noordzee; studie van de impact van boomkor- en schelpdiervisserij op het benthos; opzet en onderhoud gegevensbestanden; studie van het macrobenthos van de Noordzee

15-07-98 – : Onderzoeker verbonden aan het Nederlands Instituut voor Visserijonderzoek (RIVO), Centrum voor Schelpdieronderzoek (CSO), Yerseke.

Deelname aan symposia, congressen en studieverblijven

- Fifth International Meiofauna Conference, Gent, Belgium (16-20 augustus 1983).
- COST-symposium "Long-term changes in coastal benthic communities", Brussel, België (9-12 december 1985).
- Schelde Symposium "Hydrobiology and chemistry of the Schelde and Westerschelde", Terneuzen, Nederland (26-27 mei 1987).
- Workshop over "Taxonomy of North Sea Benthos", Helgoland, Duitsland (8-12 februari 1988).
- Meeting over "Multivariate Analysis of Biological Data: an Introduction", Meise, België (18 februari 1988).
- "International Symposium on the North Sea", Texel, Nederland (15-21 mei 1988).
- 23rd European Marine Biology Symposium "Reproduction, Genetics and Distributions of marine organisms", Swansea, Wales, U.K. (5-9 september 1988).
- Workshop over de Voordelta, Middelburg, Nederland. Verhaal: Struktuur van het macro- en meiobenthos onderzoek; Recrutering en populatiedynamiek (29 november 1988).
- Meeting over "Hydro-ecological relations in the Delta Waters of South-West Netherlands", Rotterdam, Nederland (8 maart 1989).
- Workshop over de Westerschelde, Middelburg, Nederland (11 april 1989).
- Symposium "3e Kust- en Oeverdag", Middelburg, Nederland (14 april 1989).
- ECSA-19 Symposium "Estuaries and Coasts: Spatial and Temporal Intercomparisons", Caen, Frankrijk (4-8 september 1989). Publikatie: Essink et al: Population dynamics of the bivalve Scrobicularia plana: comparisons in time and space.
- Meeting van de Nederlandse Hydrobiologische Vereniging, Amsterdam, Nederland (29 september 1989). Verhaal: De bodemfauna van de Voordelta.
- 24th European Marine Biology Symposium "Trophic relationships in the marine environment", Oban, Scotland, U.K. (4-10 oktober 1989). Poster presentatie (J.A. Craeymeersch, J. Buijs, C. Heip, J. van der Meer & A. Smaal): Structure and organization of the macrobenthos community on the south-west coast of the Netherlands.
- Workshop on the North Sea Benthos Survey, Texel, Nederland (4-6 december 1989).
- 5th International Symposium on the Interactions between Sediments and Water, Uppsala, Zweden (6-10 augustus 1990).
- ECSA-20 Symposium "The changing coastline", Kingston upon Hull, GB (24-28 september 1990). Verhaal: Macrobenthos-environment relationships in a coastal subtidal community. Publikatie: Seys et al: Evolution of the intertidal macrobenthos in the Oosterschelde after the construction of the storm surge barrier.
- KNNV Symposium "De veranderende delta" (5 Oktober 1990). Publikatie: O. Hamerlynck & J.A. Craeymeersch: Het bodemleven in de Voordelta; Poster presentatie (J.A. Craeymeersch, A. Engelberts & J. Buijs): Het subtidaal macrobenthos in de buitendelta van het Haringvliet.
- Deelname aan de SPASIBA-expeditie in het mondingsgebied van de Lena, Siberië, USSR, september 1991.
- Benthos workshop, Direktie Noordzee, Rijswijk, 3 april 1992.
- Meeting of the ICES Benthos Ecology Working Group, Bergen (Noorwegen), 4-8 mei 1992.
- Workshop FLUXMANCHE, Rijswijk, 2-3 juni 1992.
- Symposium biologische monitoring in het aquatische milieu, Amsterdam, 18 november 1992.
- BEON workshop visserij-effekten, Texel, 14-17 november 1992.
- Meeting of the ICES Benthos Ecology Working Group, Kiel (Duitsland), 3-8 mei 1993.
- Meeting of the ICES Benthos Ecology Working Group, Yerseke, 9-13 mei 1994.
- Studiedag "Schelde estuarium" Nederlandse Vereniging voor Aquatische Ecologie. Antwerpen, 26

mei 1994.
- BIOMAR-Life Workshop 'Classification of benthic marine biotopes of the North-East Atlantic', Cambridge, 16-18 november 1994.
- IMPACT-II meeting (Effects of different types of fisheries on North Sea and Irish Sea benthic ecosystems), Conwy, 17-21 januari 1995.
- Meeting of the ICES Benthos Ecology Working Group, Tórshavn (Faroe Islands), 3-6 mei 1995.
- BEON workshop 'gesloten gebieden', den Haag, 18 mei 1995.
- Meeting of the ICES Working Group on Ecosystem Effects of Fishing Activities, Copenhagen, 13-21 maart 1996.
- BEON workshop ter voorbereiding van de Nederlandse inbreng van de tussenconferentie van Noordzee- en Visserijministers (IMM 97), Wageningen, 3-4 april 1996.
- Symposium Benthos Noordzee, 23 april 1996, Den Haag. Verhaal: Bodemfauna en bodemvisserij.
- Meeting of the ICES Benthos Ecology Working Group, Aberdeen, 3-8 mei 1996.
- ECSA 26 and ERF 96 Symposium "Transport, retention, tranformation processes and their biological control in estuarine and coastal systems", Middelburg, The Netherlands, 16-20 september 1996.
- Beleidspresentatie BEON 'kartering habitats/ecotopen zoute wateren en het belang voor beleid en beheer', Den Haag, 25 oktober 1996.
- Voorlichtings- en discussiebijeenkomst onderzoek Voordelta. RIKZ, Middelburg, 21 maart 1997. Verhaal: Effecten van de schelpdiervisserij op het bodemleven in de Voordelta.
- Workshop 'Zandbanken', Instituut voor Zeewetenschappelijk Onderzoek, Brugge, 14 mei 1997.
- Lectures and workshop by Peter Turchin on NonLinear Ecological Time Series Analysis, Rijksuniversiteit Leiden, maart/april 1998.
- ICES Symposium 'Marine Benthos Dynamics: Environmental and Fisheries Impacts', Crete (Greece), 5-7 October 1998. Poster: 'Distribution and stock assessment of *Spisula* species in the Dutch coastal area'.
- Workshop 'Effects of trawling on non-target animal communities in northern Europe: biological, conservation and economic issues', Anglesey (U.K.), 7-10 december 1998. Verhaal: 'Distribution of macrofauna in relation to the microdistribution of trawling effort'.
- Meeting of the ICES Benthos Ecology Working Group, Kristineberg, Sweden 28 April - 1 May 1999
- Noordzeedagen, 23-24 september 1999. Thema: Biodiversiteit.
- ELOISE (European Land-Ocean Interaction Studies), 3rd Open Scince Meeting, 1-4 December 1999, Noordwijkerhout (NI). Poster presentatie (J.A. Craeymeersch, J. Rueda & A.C. Smaal): Feeding behaviour and abundance of *Spisula subtruncata* population in the Dutch coastal zone.
- Cursus geostatistiek (Inleiding Geostatistiek, Voortgezette Geostatistiek, Ruimtelijke Steekproeven) , april 2000, Alterra, Wageningen.
- NECOV studiedag, 28 aprils 2000, Yerseke (NI), 'Ecologische Effecten van Grootschalige Fysische Ingrepen in Estuaria en Kustgebieden'.
- ICES Annual Science Conference 2000, 27-30 september, Brugge (B).

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Buijs, J., J.A. Craeymeersch & P.M.J. Herman, 1994. BEDMAN, Benthic Data MANagement. In: Report of the Benthos Ecology Working Group, Yerseke, the Netherlands, 9-13 May 1994. ICES CM 1994/L:4, Annex 11, pp. 95-104.

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Craeymeersch, J.A. 1991. Applicability of the abundance/biomass comparison method to detect pollution effects on intertidal macrobenthic communities. Hydrobiological Bulletin 24(2), 133-140.

Craeymeersch, J.A. 1999. The use of macrobenthic communities in the evaluation of environmental change. PhD Thesis, University of Gent. 254 pp.

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Abstracts of posters

Integrated Coastal Zone Management. The way towards a sustainable coast?

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Introduction

The province of West-Flanders is, in co-operation with the ministry of the Flemish community, involved in several Integrated Coastal Zone Management (ICZM) initiatives. Their aim is to establish a co-ordination centre for ICZM, to play a role in influencing ICZM policy and to set up a strategy for ICZM.

What is ICZM?

Integrated coastal zone management (ICZM) is defined as 'a dynamic, continuous and iterative process designed to promote sustainable management of coastal zones'. Over the long-term, ICZM seeks to balance benefits from economic development and human use of the coastal zone, the benefits from protecting, preserving, and restoring coastal zones, the social benefits for the coastal populations and its visitors, and the benefits from public access to and enjoyment of the coastal zone, all within the limits set by natural dynamics and carrying capacity. In this approach the conservation and improvement of the ecological value will be linked to sustainable exploitation of natural resources.
Key words in ICZM are consultation and participation of all relevant actors in the coastal zone.

Do we need an integrated approach?

The anthropogenic and human activities in the coastal zone cause a high pressure on the coastal system. Recreation, sports, tourism, nature conservation, coastal defence, military activities, fisheries, agriculture, harbour related activities, economic activities, shipping, etc. all seek their place in the small strip of our coastal zone (65 km). To allow all these activities, there is an urgent need to analyse the future visions and developments of all activities and sectors together, this means in an integrated way. A critical reflection should be made how these activities can develop in a sustainable way.

What do we want to accomplish with ICZM?

- stimulate the sustainable use of space and natural resources
- solve conflicts in (use of) the coastal zone
- promote strategic planning in the coastal zone
- create awareness for the need for ICZM

ICZM in Belgium

Conflicts in the Belgian coastal zone can be divided in six main categories: conflicts in terms of:
(1) spatial use and fragmentation of open space;
(2) decline in quality of nature, environment and landscape;
(3) pressure caused by tourism and recreation;
(4) visual impact caused by infrastructures;
(5) transport problems (traffic jams, etc.);
(6) insufficient guarantee for safety and good quality of life.
Despite several CZM initiatives in Belgium there is no ICZM strategy yet. First several barriers must be broken.
Priority barriers are:

- there is no formal structure (responsible) for ICZM;
- the competencies are dispersed over several policy levels and sectors;
- there is no legal frame for coastal management;
- there is a lack of monitoring of parameters in the coastal zone;

- there is a strong sectoral approach and planning;
- there is a lack of co-ordination, consultation and communication;
- there is no planning at sea.

Initiatives at European and international level will hopefully help to stimulate Belgium in drawing up a future plan for ICZM.

Use of a Belgian sandy beach as a feeding ground for juvenile plaice (*Pleuronectes platessa* L.)

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Macrocrustaceans and juvenile demersal fish were sampled in spring of 1997 in the surf zone (±1m depth) of an exposed sandy beach at the Belgian coast (Lombardsijde). Three subsequent 24h-cycles were performed in order to investigate tidal, diurnal and/or semi-lunar distribution patterns. Juvenile plaice *Pleuronectes platessa* L. was the main fish species present in the samples: both 0- and I-group individuals were caught. While the 0-group seemed to move passively along with the water mass as it moves up and down the beach, a clear tidal migration pattern was observed for the I-group: highest densities were found at low water. A three-way ANOVA indicated that the effect of tide (low water vs. high water) as well as the effect of day/night and the different sampling cycles, were all significant. Combined effects however did not have a significant effect. While the extreme turbulent conditions within the surf zone of the studied site were probably too severe for the smaller 0-group plaice to cope with, I-group plaice are clearly able to withstand the turbulence.

To investigate if the high dynamics of the surf zone suppresses the ability of juvenile plaice to actively search for food, stomach content analyses were performed. The diet of the 0-group individuals mainly consisted of prey that was most abundant in somewhat deeper water (e.g. palps of the polychaete *Magelona papillicornis*). The I-group however, mainly fed on prey typical for the intertidal area (e.g. the polychaete *Scolelepis squamata*). Moreover, Fulness Indices indicated that feeding was maximal at flood tide. An opportunistic utilisation of available food resources is suggested: I-group plaice clearly disperse during flood in order to migrate high up the beach to profit from the rich macrobenthic area.

Keywords: surf zone; sandy beach; *Pleuronectes platessa*; feeding periodicity. stomach content analyses; tidal migration.

The influence of marine sand extraction on benthic copepod communities

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More than 95% of the sand extraction on the Belgian Continental Shelf occurs on the Kwintebank and is concentrated at the north-western tip and in the centre of the bank. The extraction activities impact bottom habitat structure and diversity by coarsening and homogenising the sediment and cause a strong erosion process. Density, diversity and community structure of harpacticoid copepods on the Kwintebank were determined and related to sediment characteristics and sand extraction intensity. Samples were taken in 1997 with a Reineck box corer and included 10 stations on the bank and 2 in the channels next to the bank. Eighty copepod species were recorded, of which 38% were new to science. Three major copepod communities were distinguished on the bank. Their occurrence was related to a linear gradient from fine sands in the south to coarser sands in the north. This gradient is a result of local tidal current patterns. A fourth community was found in the gullies next to the bank and in one station positioned in the centre of the bank. The sediment composition of this station however was comparable to the other bank stations. Analogies could be found in the occurrence of erosion and extraction areas and the occurrence of communities on the sandbank. The results of 1997 were compared with copepod species distribution data collected in 1978 prior to intensive sand extraction. The harpacticoid community structure of the southern part of the bank was still comparable after 20 years and hence stable in time. In the northern part the species composition altered in favour of interstitial species. In the centre of the bank a community shift was recorded due to changes in sediment characteristics, adjacent to an area with very low density and diversity. The harpacticoid communities of areas with a high amount of exposure, like on the Kwintebank, are adapted to continuously changing conditions. Nevertheless human-induced physical disturbances may decrease community complexity in the centre of the bank, where the extension of a present depression can become quite problematic. This depression may grow due to sand extraction. The presence of some harpacticoids that are adapted to physical stress and the significantly higher density of juveniles in the most intensively exploited stations, suggest the existence of a frequently disturbed environment. Spreading the extraction activities over the different sandbanks in the concession zone will help decreasing the disturbance frequency and intensity.

Organic carbon in intertidal mangrove forests: sources and utilization by benthic invertebrates

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In contrast to the large number of studies on the trophic significance of mangrove primary production to the aquatic foodweb, there have been few attempts to provide an overview of the relative importance of different primary carbon sources to invertebrates in the intertidal mangrove habitats. Mangrove sediments from three different mangrove ecosystems (Coringa Wildlife Sanctuary in the Godavari Delta, Andhra Pradesh, India, and Galle and Pambala, Sri Lanka) were analysed for their organic carbon and total nitrogen content, elemental ratios (C:N) and carbon isotopic composition. Organic carbon content (0.64 – 31.67% dry weight), C/N ratios (7.0 – 27.3) and $\delta^{13}C$ (between –29.37 and –20.61‰) showed a wide range of values. Lower stocks of organic carbon coincided with low C/N (atom) ratios and less negative $\delta^{13}C$ values, indicating import of marine or estuarine particulate suspended matter. High organic carbon stocks coincided with high C/N ratios and $\delta^{13}C$ values close, but not equal, to those of the mangrove vegetation. While in some mangrove ecosystems or vegetation zones, organic carbon stocks can be very high and are almost entirely of mangrove origin, there also appear to be cases in which deposited estuarine or marine suspended matter is the dominant source of organic carbon and nitrogen in mangrove sediments. At one such site (Coringa Wildlife Sanctuary), 23 invertebrate species and different primary producers were collected and analysed for their carbon and nitrogen stable isotopic composition ($\delta^{13}C$, $\delta^{15}N$) in order to determine the contribution of mangrove leaf litter and other carbon sources to the invertebrate community. These invertebrates were found to display a wide range of $\delta^{13}C$ values, most being 3-11‰ enriched relative to the average mangrove leaf signal. Two invertebrate species displayed remarkable stable isotope signatures: the pulmonate gastropod *Onchidium* sp. had extremely low $\delta^{15}N$ values (-5.58 ± 0.86‰) and Polycladia hosting endosymbiotic algae showed low $\delta^{13}C$ values (-36.2 ± 0.8‰), but further work is needed to adequately explain these. A compilation of stable isotope data from various sources indicates that significant assimilation of mangrove-derived carbon is only detectable in a limited number of species, and stresses that local and imported algal sources can be a major source of carbon for benthic invertebrate communities in intertidal mangrove forests. These findings show a striking similarity with results from temperate salt marsh ecosystems where local plant production has often been found to contribute little to intertidal foodwebs, and thus provide new insights into carbon utilization patterns in vegetated intertidal ecosystems.

A survey system for dredging[1]

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In bathymetry, the seafloor's depth is sounded at discrete spots. For dredging works, it is important to have as good a terrain model as possible, as well before dredging starts as after the work has been carried out.

The latest bathymetric sounding equipment that is available nowadays, especially the multibeam echosounder, yield a very dense bottom sampling. When compared to the common singlebeam echosounder, an enormous amount of data is produced that needs to be processed in a correct and fast way. Grid-overlay (linear interpolation by means of a regular mesh) is not an option here as this method yields an interpolation of the measured values and hence will either cause accuracy loss or generate a still larger amount of data. A triangular irregular network (TIN for short), especially the Delaunay triangulation (Dt), does respect the actual measurements and will not generate new data. In literature, a number of algorithms have been developed that determine the Dt of a set of points given in the plane.

The speed of an algorithm is expressed as a function of n, the number of points to be processed. A straightforward algorithm to obtain a Dt is adding the points one by one to an initial triangulation made of a subset of the data. This method requires n^2 manipulations. However, algorithms exist, under which a *divide-and-conquer* algorithm, that require only $n.log(n)$ manipulations. That has been proved to be theoretically the best possible performance. This means a considerable gain in calculation time of the concerned data files, which typically will contain about 10^6 points. It will be clear that the processing time for both algorithms will even more diverge for increasing data sets.

Therefore, the first and most important part of the project consists of optimally implementing the divide-and-conquer algorithm. This is done in Object Pascal under Delphi. Delphi also allows to easily create a user interface.

A next step is to introduce breaklines. Breaklines will mainly occur in the design models. The height along these lines is theoretically fixed and should not be cut by any triangle edges of the Dt.

Part of the immense amount of data generated by a multibeam echosounder will unavoidably be redundant. An important issue therefore will be: filtering these data, keeping those points that still assure an optimal accuracy for the final volume calculations.

Another required function is manual editing of the TIN. Adding points can be done by reusing the already implemented incremental algorithm. Deleting points remains to be sorted out.

In a later phase, once the core of the program is finished, other user friendly features will be added.

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[1] 'Survey-systeem voor het baggeren' is an IWT project in collaboration with the University of Ghent, Geography Department and Dredging International NV

An 18 S rDNA based molecular phylogeny of the Mysidacea (Crustacea)

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The phylogeny of the Mysidacea, an order of small, mostly hyperbenthic peracarid crustaceans, was studied using the base sequence of the 18S rDNA gene. 25 species, belonging to the most important taxa, were analysed. To this end the DNA of the specimens was isolated and the gene amplified in a PCR-reaction, using two oligonucleotide primers. These primers flanked the 18S region of the DNA, which was to be amplified. The technique used for sequencing the gene was the dideoxymethod developed by Sanger. The sequences were automatically aligned using ClustalW 1.74. The resulting alignment was improved by hand using DCSE to obtain the optimal alignment. Aligning is a very important step because the alignment expresses the distance between two species and is the basis of the derived phylogeny. As a next step, molecular phylogeny was inferred using three different methods: Neighbour Joining (NJ), Maximum Parsimony (MP) and Maximum Likelihood (ML). The programs used were, for NJ, TreeconW and PAUP* version 4.04b4, for ML, PAUP* version 4.04b4 and for ML, Puzzle 4.0.2 and FastDNAml version 1.2.1. Generally the results from these three methods, using the different programs, are very similar. The Leptomysini are clearly monophyletic, but the genus *Mysidopsis*, is, in its present definition, polyphyletic. The Gastraosaccinae, without the genus *Anchialina*, are monophyletic as well and the traditional division in genera within the taxon is supported. The Mysini are clearly not monophyletic. On the basis of these data, this problem can be solved by incorporating the clade, consisting of *Neomysis*, *Acanthomysis* and *Holmesimysis*, in the Leptomysini. The genus *Mysidium* cannot be placed unambiguously in the phylogeny using this set of data. The results from the analyses, using the three different methods, also clearly show that the 18S rDNA does not contain enough information to fully resolve relationships between the higher taxonomical units within the Mysidacea.

Dissolved barium in the Southern Ocean: conservative vs. non-conservative behaviour as constrained by a multiple end-member mixing model

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Understanding the factors controlling the dissolved oceanic Ba distribution is an important task to improve our knowledge of the biogeochemistry of the Ba proxy. As a bio-intermediate element, the oceanic Ba_d contents consist in a non-conservative fraction (mainly controlled by biogeochemical processes) and a conservative fraction (essentially modified by mixing processes). We investigated to which extent the dissolved Ba is conservative using a multiple end-member mixing model approach in which Ba was used as a mixing tracer in combination with Θ, S and O_2. Six watermasses known to contribute to the composition of the intermediate and deep waters in the Southern Ocean were used in an Optimal Multiparametric Analysis model (OMPA): a northern component (North Atlantic Deep Water), two southern component (Weddell Sea Bottom Water and Warm Deep Water), a circumpolar component (Intermediate and Deep Drake Waters) and an intermediate component (Antarctic Intermediate Water). OMPA modelling was applied to data obtained during WOCE/I6 CIVA-1 expedition (1993, 30°E). For this section located at the boundary between Atlantic and Indian Oceans, O_2 and Ba model outputs suggest the occurrence of a source originating from the Indian Ocean at intermediate depths between 44° and 54°S, probably advected by the Agulhas Current and the Agulhas Retroflexion. Furthermore, model calculations indicate that bottom water possibly coming from the shelf east of 30°E is required to explain the calculated dissolved Ba distribution in bottom waters between 54 and 56°S and 68°S. Archambeau *et al.* (1998) suggested that this water could originate from the Prydz-Bay area and the present study shows that deep Prydz Bay Slope Waters could be such a source. We demonstrate that, on the time and geographic scales of inter-basin and intra-basin exchanges, the dissolved Ba is useful to constrain the relative contribution of source waters and it can be used as more classical tracers (Nitrate, Phosphate) but without their inherent problems due to the varying Redfield ratio.

Another required function is manual editing of the TIN. Adding points can be done by reusing the already implemented incremental algorithm. Deleting points remains to be sorted out.

In a later phase, once the core of the program is finished, other user friendly features will be added.

Biogeochemical reworking of sewage discharged in the Scheldt Estuary (Belgium) influences nitrogen and carbon isotopic composition of the aquatic food chain

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Stable C and N isotope ratios were used to study food web characteristics of the brackish part of the Scheldt Estuary. The river Scheldt is a highly eutrophic system due to heavy antropogenic disturbance as indicated by high organic matter and ammonium loading. By means of stable isotope analysis, an attempt was made to detect trophic relationships of the aquatic food chain. Therefore, baseline C and N isotopic ratios were investigated monthly from May 1999 to March 2000 by measuring the isotopic composition of suspended particulate organic matter (SPOM). Also the $\delta^{15}N$ and $\delta^{13}C$ composition of species representing different trophic levels of the subtidal food web (copepods, mysids and fish) and the intertidal food web (endobenthos, shrimps and crabs) were investigated.

$\delta^{13}C_{SPOM}$ and $\delta^{15}N_{SPOM}$ values varied seasonally with $\delta^{13}C$ values ranging from –23.7 (January 2000) to –28.0‰ (June 1999) and $\delta^{15}N$ values ranging from +2.3‰ (January 2000) to +12.9‰ (June 1999). For copepods, $\delta^{13}C$ and $\delta^{15}N$ values varied from –30.7 to –26.4‰ and from +11.1 to +25.5‰ respectively. $\delta^{13}C$ and $\delta^{15}N$ values of copepods exhibited a seasonal variation and $\delta^{15}N$ co-varied with $\delta^{15}N_{SPOM}$. $\delta^{13}C$ values of two dominant mysid species varied between –29.0 and –25.5‰, $\delta^{15}N$ values varied between +11.8 and +25.0‰. Fish $\delta^{13}C$ values displayed a wide range, from –26.4 to –34.3‰ and $\delta^{15}N$ values from +15.7 to +33.5‰, depending on the trophic level. In the intertidal food web, macrocrustacea isotopic compositions ranged between –29.0 and –18.1‰ and +17.5 and +26.8‰ for $\delta^{13}C$ and $\delta^{15}N$ respectively, while endobenthic species had $\delta^{13}C$ values between –21.4 and –24.4‰ and $\delta^{15}N$ values between +19.2 and +22‰.

The $\delta^{15}N$ values were high compared to other estuarine environments. According to Hansson *et al.* (1997), such a situation reflects a high degree of pollution. However, in the present case, ^{15}N-enrichment in the food chain is not the result of isotope composition of the waste source. Indeed, $\delta^{15}N$ of sewage SPOM from the Brussels sewer system, which is discharged untreated into the Scheldt via the Zenne and Rupel tributaries, does not exceed +3‰ (Fisseha, 2000), while $\delta^{15}N$ of riparian vegetation averaged +1.5‰ (Mariotti *et al.*, 1984). Therefore, the ^{15}N enrichment in the Scheldt trophic system is probably the result of organisms feeding on organic matter which has become enriched during river transport to the North Sea. Intense biogeochemical reworking of the N pools (bacterial mineralisation, followed by nitrification and denitrification) are the probable processes enriching ^{15}N in the nutrient pool (NH_4^+) utilised by bacteria decomposing detritus (Caraco *et al.*, 1998) and by phytoplankton (Mariotti *et al.*, 1984). These biogeochemical processes are probably subject to seasonal variability as indicated by seasonal variability of $\delta^{15}N$ signal in SPOM and copepods. Similarly to the pelagic food chain, ^{15}N enrichment of the intertidal food chain due to the incorporation of enriched DIN by phytobenthos has been mentioned by Riera *et al.*, (2000).

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The influence of nematode diversity on the decomposition of organic matter and on the associated bacterial community: an experimental approach

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The last few years, biodiversity is a hot topic in biological research. Most studies concentrate on describing and comparing diversity in different (micro)habitats. Only few studies have examined the role of biodiversity, i.e. the relationship between diversity and process rates.

This project aims to characterise the role of free-living nematodes in the decomposition of plant-derived particulate detritus in a brackish saltmarsh. Nematodes are the dominant metazoan group in saltmarshes and are characterized by a high species diversity. A stimulatory effect of nematodes as a group or of single nematode species on decomposition is known, but this project focuses on the relationship between nematode species diversity and decomposition rate.

Most nematodes associated with cordgrass (*Spartina townsendii*) belong to the same trophic guild ('deposit feeders') and bacteria are representing their main food source. Because of their seemingly low functional diversity, these nematode communities are ideal for the study of species redundancy in ecosystems. The central hypothesis in this project is that nematodes will affect the decomposition process of *Spartina*-detritus, but that this will be independent of species identity or diversity; in other words, nematodes in this decomposition system have a single 'function' that can be maintained by a single species, others thus being redundant.

In order to test this hypothesis, laboratory incubations of *Spartina*-detritus with and without nematodes have been performed. A total of seventeen treatments were kept under controlled abiotic conditions for 100 days: 4 single species additions, 6 two-species combinations, 4 three-species combinations, one four-species combination, one five-species combination and one controle treatment without nematodes. Samples were taken every 10 days. In every sample the nematode community, the bacterial community and the decomposition will be analysed.

Nematodes are being counted and biomasses calculated. The decomposition process will be followed by measurements of weight loss, C/N/P-content and protein content of the organic matter. Bacterial activity is represented by respiration rates, enzyme activity and ATP-measurement. The composition and diversity of the bacterial community will be revealed by the molecular technique DGGE (Denaturing Gradient Gel Electrophoresis).

Future experiments will consist of supplementary laboratory experiments and *in situ* incubations using litter bags.

'Hovland' mounds in Porcupine Seabight, NE Atlantic: biological zonation and environmental control

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The 'Hovland' mounds occur in the northern part of the Porcupine Seabight between 52°30'-52°N and 12-13°W, in water depths between 725-900m. 'Hovland' mounds occur as single conical mounds or elongate composite mounds. Linear segments of composite mounds are mostly oriented NE-SW, apparently independent of bathymetry or structural lineaments. In general the mounds have an average slope of 10°, the steepest flanks are located just below the crest with slopes up to 25°. The 'Hovland' mounds root on a surface, the youngest of a complex cut- and fill system. Erosional moats and depositional tails flanking the seabed mounds create local variations in thickness of the embedding sediments. The association of the mounds with current-related features such as moats, sediment tails and biological zonation indicates their location in regions of strong currents. Zonation and biodiversity of the present *Lophelia* reef complexes was investigated by means of videotransects and boxcoring across some of the mounds. Mainly the northern flanks of the mounds showed pathy *Lophelia* communities in association with a divese epifauna of mainly sponges and polychaetes. Along these flanks the biological communities showed a symmetrical zonation pattern. Often, a small patch of living *Lophelia* in the centre of the mound slope gradually shifted both sides along the slope in to a dead coral zone that finally extends into a corla rubble zone. In general *Lophelia* showed a patchy distribution interrupted by small areas of sediment.

On-mound sediments are intensely bioturbated and are dominated by terrigenous components. They also contain a large amount of bio-detritic material; azooxanthellate corals (*Madrepora*, *Lophelia*) and shells. The carbonate in the terrigenous mud is covered by coccolithophores, foraminifers, spicules of octocorals, gastropods, crustaceans and coral rubble. Age estimations based on calcareous nannofossil biostratigraphy of a shallow core provide an approximate age of 72ky at 3.3m sediment depth. If the inferred sedimentation rate is extrapolated to the base of this particular mound, mound initiation would have occurred during the Late Pliocene, about 2.2 Ma BP. Mound growth started more or less simultaneously after a period of erosion and non-deposition. This start-up event suggests drastic environmental changes that favoured coral growth at a certain period. Such changes may have been triggered by changes in the oceanographic circulation patterns with the inflow of Mediterranean Outflow Water in the Porcupine Basin.

Taxonomy and biogeography of the shallow water Mysidacea of the Western Indian Ocean – taxonomic and biogeographical research by use of taxonomic databases

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Up to date, a complete overview of the Mysidacea fauna for the Western Indian Ocean (WIO) was limited to species lists and overview reports on discrete regions, mainly due to lack of technology. The development of the Mysidlan database has made it possible to manage big amounts of information in a systematic and organized way.

The Mysidlan database was built in order to manage both ecological, morphological and biogeographical data on the Mysidacea. Relevant data on the shallow water Mysidacea of the WIO were collected from all the available (published) information of the region, including original information from the east coast of South Africa and the north of Mozambique.

The advantages of Mysidlan compared to other taxonomic databases are:

- all data are based on published information available (digitally) in the database
- full search possibilities
- interaction with all recent software is easy

The database consists of two parts: part 1 is containing systematic, morphological, ecological and geographical information and part 2 is presenting the collection of information sources.

With this new tool, a complete overview of the actual knowledge of the Mysidacea of the WIO is given; a biogeographical review is presented and a hypothesis on possible relationships between biogeographical and tectonic processes or water circulation patterns is proposed.

Next to these interpretations, identification keys were developed and taxa which need to be reviewed in the future, are indicated.

Broadening the current dataset into a database on the world Mysidacea fauna will enlarge the value of taxonomic databases like Mysidlan.

Preliminary analysis of new records of Plocamium species for the South African East Coast

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Of the 16 Plocamium species recorded from the Indian Ocean, 9 occur in South Africa. The greatest diversity within this taxon is found on the South coast (between Cape Point and Port Elizabeth, viz. 8), while only 4 have been reported from the East coast viz. *Plocamium affine* Kützing, *P. beckeri* Schmitz ex Simons, *P. collorhiza* (Turner) Hooker & Harvey and *P. suhrii* Kützing. Two new records and two potential new species have been found during recent collections on the KwaZulu-Natal and Transkei coasts. *Plocamium telfairiae* (Hooker & Harvey) Harvey ex Kützing, a species described from Mauritius and reported from Mozambique, was found in northern KwaZulu-Natal. This species is morphologically variable, having at least three discernable forms. One of these forms bears a resemblance to *P. sandvicense* J. Agardh. Also, a number of specimens resembling *Plocamium abnorme* f. *uncinatum* Okamura were collected. Okamura later transferred this species to *P. telfairiae*, but there is some doubt as to whether this form is a new species or not. *Plocamium* cf. *microcladioides* South & Adams, a New Zealand endemic, was also found within the study area. Our material was slightly narrower than the described specimen and exhibited some characteristics of *P. beckeri* and *P. cartilagineum* (Linnaeus) Dixon. *Plocamium* cf. *mertensii*, a relatively large low intertidal to shallow subtidal species; and *Plocamium* sp. 1, a relatively small, recent, deep subtidal species, are described. The establishment of new species will be proposed once the relevant type material has been studied.

Air-water exchange of nutrients and inorganic trace elements on the North Sea and over the French-Flemish North Sea Coast

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There is a great uncertainty concerning the atmosphere as a source of nutrients to the North Sea. Especially during the summer months, when the riverine input is at a minimum and ammonia emissions are at a maximum, the atmosphere can become an important source of nutrients. Therefore, it happens that during late spring and summer, when algal primary production in the North Sea appears to be nutrient limited and when some parts of the North Sea are, due to the natural current, isolated from the North Atlantic inflow, the atmosphere becomes the dominant source of nitrogen compounds. These nutrients can cause algae blooms and even eutrophication over large sea areas, resulting in a damaged natural equilibrium of the ecosystem. At the end of these blooms, hypoxic and even anoxic states can occur, resulting in a massive mortality in the marine flora and fauna.

Various sampling campaigns were organised to increase the knowledge of the anthropogenic pollutants and the sources of the nutrients. The pollution on the North Sea was investigated on the research vessel Belgica. During eight different campaigns, from 1998 until 2000, samples were taken from the Channel to the Central North Sea on various fixed sampling points.

Marine and continental influences were examined at the Belgian coast in Adinkerke, Blankenberge and Knokke-Heist. In Knokke-Heist, samples were taken on a weekly basis over a period of one year (from June 1999 until May 2000). At the sampling point of Adinkerke, near the French border, the borderline transport of pollutants and the impact on the environment was investigated. Intensive sampling campaigns of a period of one month (June 2000, December 2000 and February 2001) were organised to improve the knowledge on the seasonal variations of the pollution.

The particulate matter was sampled, using filter holders and glass fibre filters for nutrients (NO_2^--, NO_3^--, PO_4^{3-}- and NH_4^+- compounds) or Nuclepore filters for trace elements. These trace elements under investigation either have a biological role (Al, Si, Mn, Fe) or are very toxic (Cd, Pb, Cr, Ni, Cu, Zn). Impactor samples were taken in order to achieve some additional information concerning the particle size of the pollutants and the history of the air masses. Primary and secondary sea salt particles and the pollutants and their reaction products give information concerning the origin and the anthropogenic or marine influences of the air masses. Gaseous nutrients, like ammonia, nitrous acid and nitric acid are sampled, using a denuder set-up.

After the analysis with Ion Chromatography, the data are compared with meteorological data (air mass back-trajectories) and fluxes will be calculated.

Tidal, diel and lunar changes in estuarine marsh nekton

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The utilisation of a brackish estuarine marsh by nekton was investigated over a lunar cycle in August 1994. The nekton migrating in and out of the intertidal creeks of the marsh 'Het Verdronken Land van Saeftinghe' in the Westerschelde estuary, SW Netherlands, was sampled passively during seven complete tidal cycles. Sampling one tidal cycle yielded three consecutive flood samples and four consecutive ebb samples. Sampling occasions, occurring every two to three days, covering all diel and lunar situations allowed comparing tidal, diel and lunar influences on the composition of the intertidal nekton fauna.

Two different tidal migration modes were observed. The mysid shrimp *Mesopodopsis slabberi* showed maximum abundance around high tide. For the remaining common nekton species: the mysid *Neomysis integer*, the shrimps *Palaemonetes varians*, the amphipod *Corophium volutator*, the crab *Carcinus maenas* and the goby *Pomatoschistus microps*, highest densities were recorded during lower water heights. The fauna assemblage shifts clearly between the different tidal stages. The total amount of detritus was found to be the most important parameter structuring the assemblages.

On two occasions consecutive day and night samples were taken. Total densities were clearly higher during night samples. During full moon a clear difference in community composition was noticed between the night and the day samples. During neap tide, differences between day and night were less clear.

No clear correlation was found between water height and total nekton densities. Except for the two most abundant species *Mesopodopsis slabberi* and *Neomysis integer* of which recorded averages were higher during spring tide and lower during neap tide. A clear shift in community composition was observed between the spring tide and the neap tide with water height as the main environmental factor.

The black box: a story of the brown shrimp and the (un)faithful mysids in the Westerschelde estuary

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The estuarine population of the brown shrimp *Crangon crangon* in the Westerschelde was sampled with a 3-metre beamtrawl and a hyperbenthic sledge with RV Luctor and with a 2-metre beamtrawl with the Riekus during several campaigns.

During the period 1999-2000 the densities of the brown shrimp were lowest in winter and highest in summer, respectively 1 and 4.5m^{-2} in the brackish zone, where the densities were twice as high as in the marine zone of the estuary. Ten years earlier, between 1988 and 1991 the densities were approximately twice as high (max. 6.5m^{-2} in August), as well in the marine as the brackish zone during all seasons, but especially in November. Even during a 24 hour sampling campaign in the brackish zone in September 1991 — the peak period for shrimps — the densities were much higher, on average 17m^{-2} with a maximum of 30m^{-2} in the afternoon. The difference between the seasons was extreme in the brackish intertidal in 1992 as densities were between 60 and 80 times higher in summer (4m^{-2}) and fall (5m^{-2}) than in spring (0.05m^{-2}) with a maximum of 20m^{-2} in October.

Analysing the diet was rather difficult as in most of the stomachs the prey items were almost completely crushed. Most probably shrimps use sand grains to help them with this job, as between 70 and 90% of the non-empty stomachs contained sand grains from a few to several hundreds per stomach. Furthermore, respectively in 40% and 20% of the stomachs unidentifiable crustacean parts and other unidentified matter was found.

Shrimps show a tidal feeding rhythm, with highest number of shrimps with some food in their stomachs at high water, as well during day as night. Shrimps seem to eat more in the brackish zone (more than 70% non-empty stomachs in the subtidal and even 90% in the intertidal) while in the marine zone on average 50% of the stomachs had some food particles in their stomach.

During the 24 hour sampling mysids (mainly *Neomysis* and *Mesopodopsis* and to a lesser extent *Gastrosaccus*) were the most important prey items (Frequency of Occurrence >90% of the non-empty stomachs). Even 10 years after, mysids constituted more than 70% of the shrimp diet in September. In May mysids were still an important prey item, surely in the marine zone (FO 70%), but in autumn and winter the occurrence of mysids in the diet dropped to 20%. In the intertidal mysids are infrequently preyed upon by shrimps. Here, amphipods (*Corophium* and *Bathyporeia*) constituted the main part of the diet (FO 40%).

Other less important prey items are bivalves (mainly *Mytilus* spat), polychaetes (mainly *Nereidae*), ostracods, copepods, cypris larvae and gastropods (mainly *Littorina*).

Volatile organic compounds as priority pollutants in the North Sea

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Volatile organic compounds (VOCs) are ubiquitous in the marine environment. They are known to affect a wide number of biological and ecological systems and therefore represent a potential threat to the North Sea environment as stated by several international organisations. Nine VOCs, all chlorinated C_1- and C_2-hydrocarbons, have been included on a list of 36 priority toxic pollutants at the Third International Conference on the Protection of the North Sea[1]. Additionally to this priority list, it was stated that attention has to be paid to 13 groups of chemicals, out of which four consist of VOCs. Furthermore, short chain chlorinated paraffins and trichlorobenzenes have been classified by OSPARCOM (Oslo and Paris Commissions) as chemicals for priority action. Finally, a number of chlorinated hydrocarbons and monocyclic aromatic hydrocarbons have been selected by the Marine Chemistry Working Group (MCWG) as chemical parameters in the Water Framework Directive.

However, compared to other priority pollutants, e.g. polychlorobiphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), chlorocyclohexanes (CHCs), pesticides or heavy metals, far less information concerning the presence and input of VOCs in the marine environment is available.

27 VOCs, *i.e.* chlorinated alkanes and alkenes, monocyclic aromatic hydrocarbons and chlorinated monocyclic aromatic hydrocarbons are currently investigated in order to acquire a better understanding on the sources, masses and fluxes of these compounds in the North Sea. The target compounds were selected from lists established at the Third International Conference on the Protection of the North Sea and cover a wide range of VOCs of environmental interest. First, appropriate analytical techniques have been evaluated to allow ultra-trace determinations of VOCs in air[2] and water[3] samples. Besides method validation, emphasis was put on quality control and assessment during measurements of VOCs in marine samples. Guidelines proposed by the QUASIMEME[4] (Quality Assurance of Information in Marine Environmental Monitoring Programmes in Europe) working group were applied to all stages of field and laboratory work. Next, physical-chemical parameters, which control the dynamics of the target VOCs in the marine environment, e.g. volatilization, such as Henry's law coefficients were investigated. Finally, sampling campaigns were conducted with the research vessel 'Belgica' and 'Luctor' on the Southern North Sea, the Belgian Continental Platform, the Channel and the Scheldt estuary. Hence, these data should allow to model the physical-chemical dynamics of the target compounds in the North Sea environment.

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An integrated technical research of beach nourishment design for the Flemish East Coast

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Along the Flemish East Coast persistent regression of the coastline forms an acute threat. The natural shore profile is gradually weakening and intervention is needed to ensure a sufficient safety level of shore protection. Long-term field records clearly identify that, due to the complex interaction of wave-induced on- and offshore transport, longshore tidal drift and the impact of the breakwater obstruction by the harbour extension of Zeebrugge, a structural erosion problem occurs. Several beach replenishments were already executed in the last 25 years. In order to identify the drastic instability and the morphological impact on the area, an extended research program is set up to explore a basic understanding of the local beach morphology.

As an initial link in the actually popular integrated 'coastal zone management'-chain, an integrated hydromorphological study is explored. By using physical model tests (in collaboration with the Flanders Hydraulics Laboratory) together with computer simulations (SBEACH-software) and in-situ registration, a complete synergy between all components leads to a fully integrated description.

The initial physical scale model tests in a 1D-wave flume generate an overall qualification of the beach nourishment stability as a cross shore unit. Simultaneous numerical simulations reveal some interesting agreements and operational (sensitive) features. The extended 2D-physical model generates a realistic sediment transport development under the complex hydrodynamics, as a combination of perpendicular random waves, longshore ebb-flood currents and vertical tidal variation, confirming the local structural erosion problem.

As a result, an optimum beach protection for the studied coastal area should surpass the traditional sand suppletion if one is looking for a long-term stable beach policy. A perched beach with gravel foot protection at the foreshore can be an alternative solution to the actual, regular maintenance suppletion in this case.

Modern large submarine slides on continental margins: a case study on the Antarctic Peninsula margin, the Gebra Slide

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The high-tech evolution of the last few decades made it possible to push economic activity to the deeper offshore marine domain – with the development of sea harbours, platforms in the open sea, offshore petroleum industry, etc. The construction of bottom-mounted engineering structures, pipelines and communication cables was carried out with the help of a whole battery of sea floor survey methods: navigation technology, echo-sounding, side-scan sonar, seismic profiling and coring. In this way geologists and engineers learned about the very dynamic geologic processes acting on continental slopes and their morphologic expression on the seafloor. In the mean time, they began to appreciate that submarine slope instability is a widespread phenomenon in a variety of offshore environments (from shallow water to the deep ocean floors) and variable dimensions (up to 2.10^4 km^3 of demobilized material). In the presented work we want to focus on large scale instability events, which form an important element in the redistribution of marine sediments from the continent towards the deeper basin and in the constitution of continental slope topography. Since the Late-Quaternary significant sections of the world's continental margins have been affected by these giants slides/slumps.

Analysis of the conditions that cause submarine slope instability is a difficult task; the effective failure often depends on a complex interaction of variables. The basic conditions for any slope failure exist when stresses exerted on the sediment are sufficient to exceed the sediment strength. This can be the result of stress increases, strength reduction, or a combination of the two. Various trigger mechanisms have been proposed to initiate sliding. (1) Earthquakes or (2) surface water waves may be sufficient for failure where the sediment strengths are low. (3) Rapid sedimentation in front of e.g. river mouths clearly favour the build-up of excess pore pressures and subsequent sediment failure, particularly in fine-grained sediment deposits. (4) Seepage of shallow gas has the same effect. Other mechanisms are dealing with an oversteepened margin in offshore delta areas and canyon heads (5) or erosion at the toe of the slope (6).

High-latitude continental margins, which have been influenced by an ice sheet during the last glacial maximum seem to be particularly prone to instabilities – for example the east Canadian continental slope and the Norwegian-Svalbard Sea margin. The Storegga Slide along the Norwegian margin blanks the seafloor over an area of 112.500 km^2 and has a total volume of about 5600 km^3. Here, we present the first reported Late-Quaternary slide on the glacial margins of Antarctica: the Gebra Slide. Multibeam bathymetric EM12/EM1000 data reveal the slide scarps in the present day seafloor over a length of 30 km, ranging from 1500 m to 2000 m of water depth on the lower slope of the Antarctic Peninsula Slope. The slide scarp area is about 230 km^2. Based on seismic airgun profiling an associated mobilized sediment deposit (a debris flow) could be mapped in the deeper basin over an area of 315 km^2 and with a volume of 20 km^3. Interpretation of the seismic stratigraphy puts the age of sliding near 14.000 B.P. – around the end of the last glacial maximum. Triggering of the slide was probably favoured by the combined effect of earthquake activity and an increased sediment influx in front of a glacial trough.

Subtidal understorey algal community structure in kelp beds around the Cape Peninsula (Western Cape, South Africa)

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The subtidal understorey seaweed communities were studied along a coastal distance of 104km around the Cape Peninsula, which is situated in an overlap region between two marine provinces and characterized by a considerable temperature gradient. Sampling was carried out at six sites (4 to 10 quadrats per site) around the Cape Peninsula. For each of the quadrats, biomass of each species, grazing, and environmental variables such as temperature, wave exposure and sand cover were determined. The data were analysed using canonical correspondence analysis (CCA) and two way indicator species analysis (TWINSPAN). A total of 142 seaweed taxa were found at the six sites (21 Chlorophyta, 14 Phaeophyta and 107 Rhodophyta). The two sides of the Peninsula have a very different biomass-composition of Chlorophyta, Phaeophyta and Rhodophyta. The biomass of Rhodophyta in the Atlantic sites is much higher than in the Bay, and the biomass of Chlorophyta is higher in False Bay than on the west coast. A change in floristic composition of subtidal algal communities around the Cape Peninsula can be observed and is principally related to seawater temperature and wave exposure. Next to these physical factors, grazing is demonstrated to be important in determining species composition. A lower degree of wave exposure might result in a higher number of grazers in False Bay. The occurrence of a higher cover of encrusting corallines in the Bay is probably a consequence of the higher grazing pressure. Distinct community types can be recognized from TWINSPAN and CCA.

Genetic structure of (sub)adult European eel (*Anguilla anguilla* L.) based on allozyme markers

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The life history of the European eel remains somewhat of a mystery. Adult eels are thought to spawn in the Sargasso Sea, where the newly hatched larvae start their journey to the European continent along the North Atlantic Current. They spend most of their life in the rivers until they metamorphose after about 10 years into silver eels and then return to their spawning grounds. Most studies on European eel considered the species as panmictic and highly homogeneous. However, some elements point to the heterogeneity of European eel.

In this study 309 (sub)adult European eels were examined at 18 different allozyme loci at 7 localities dispersed throughout the natural continental range. The aim was to determine (1) the genetic diversity and structure of the European eel across Europe, (2) if the genetic structure is in agreement with the results on glass eel and with literature, and finally if there is any evidence of selection forces comparable to those in American and Japanese eel.

We show that the 7 European eel populations are poorly differentiated, which is not surprising considering the impressive spawning migration and because the analyses were made outside the spawning grounds of the Sargasso Sea. A significant genetic difference was observed between the male and the female silver eel from the Dutch populations, which may indicate a relation between sexual differentiation and genetic structure. The longer impact of selection on female individuals could be one explanation. Unusual alleles were discovered in several individuals of the Irish and second Dutch population, which might be linked to introgression of American eel in the European eel species. Finally, we describe a significant geographical cline for three alleles at two loci. Such results have also been observed in the American and Japanese eel. This might point to the selection hypothesis, because so far there is no knowledge on genetic isolation among the European eel.

Keywords: Population Genetics; clinal variation; European eel, allozymes.

MEDIA: a modelling environment for surface sediment biogeochemistry

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Surface sediments of oceans, estuaries and rivers are highly active geochemical environments. In recent years, there is a remarkable interest for a thorough quantitative understanding of the physical, chemical and biological processes governing sediment biogeochemistry. This new emphasis is being driven by both fundamental and applied objectives. Pressing environmental problems, such as predicting the fate and transfer rates of contaminants in aquatic sediments, now demand numerical answers. Moreover, mathematical models can assess the complex role of the sediment in the global biogeochemical cycles of carbon, nitrogen and other elements. Important topics include benthic-pelagic coupling (i.e. the quantification of fluxes across the sediment-water interface) and the interpretation of the historical sediment record in the light of ocean paleochemistry and climate studies.

Quantitative predictions and explanations of sediment biogeochemistry are possible through the application of so-called diagenetic models, which incorporate mass and momentum conservation equations for the different species in the surface sediment. Within the field of diagenetic modelling, a significant amount of problem-solving knowledge has been acquired from past modelling projects. Over the past four decades the field has shifted from simple analytic models, which need many simplifying assumptions and can only provide a limited qualitative understanding, to large and complex numerical models, which need extensive coding as a computer application, but give realistic and mechanistic description of sediment biogeochemistry. In recent years, a number of example applications have illustrated the capacities of such sophisticated numerical model codes for the integrated modelling of biogeochemical cycles (Soetaert *et al.*, 1996; Wang and Van Cappellen, 1996; Boudreau *et al.*, 1998). Although intrinsically powerful applications, the current numerical model codes still show a number of weaknesses: (1) models are site-specific, as they incorporate a fixed set of species and reactions, which limits the type of diagenetic problems and environments to be investigated (2) models lack flexibility and extendibility, and the associated need for low-level reprogramming and recompilation constitutes a major barrier for potential model users. A grand challenge is to encapsulate the present know-how into an easily used and flexible environment, and to bring this problem-solving power within reach of geochemists that are not familiar with computational issues.

Meeting this challenge constitutes the central philosophy behind the MEDIA project (Modelling Environment for DIAgenesis). The MEDIA environment comprises a flexible and extensible software system that provides problem-solving assistance for simulating the biogeochemistry of surface sediments. The MEDIA modelling environment is built on two fundamental strongholds:

(1) Problem solving environments, a modern concept from the field Computation Science and Engineering (CSE). Rather than focusing at a single model, a Problem Solving Environment (PSE) comprises a computer application that provides all the computational facilities necessary to solve a *target class* of related problems. These features include model construction possibilities, advanced solution methods and ways to easily incorporate novel solution methods. Moreover, a PSE uses the 'natural language' of the target class of problems, so users can run them without specialized knowledge of the underlying computer hardware or software.

(2) Object-oriented technology, the ground breaking new paradigm from the field of Industrial Software Engineering. Within MEDIA generic model construction was introduced i.e. the application user is allowed to assemble a diagenetic model from a toolbox of available model components (species, processes). Due to the introduction of an object-oriented database new

components (e.g. new species and reactions) can be added without the need for writing a single line of new code.

Succinctly stated, the MEDIA environment transfers the control on diagenetic model formulation from the application author to the application user, enables the design of customer-tailored diagenetic models built from a set of basic building blocks and provides an efficient numerical solution procedure for these models.

The acoustic response of the seafloor

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In the framework of a variety of projects, acoustic techniques have been used to study and map the seafloor. Although these techniques serve as general accepted tools for marine exploration, the use of digital side scan sonar and multibeam offer today a wide range of application levels for different scientific and commercial purposes.

For years, digital terrain models (DTM's) of the seafloor were produced from narrow spaced single-beam echosounding data, which often implied a strong simplification of the more complex environments. If analogue side scan sonar data was available, the occurrence and geometry of bedforms was manually redrawn from the imagery and superimposed on a general bathymetrical map. This process was very time consuming and often susceptible to inaccuracies. Moreover, the hierarchical link between the different types of bedforms and especially their relation with the larger sedimentary system was often missing.

Since then single-beam echosounders become more and more replaced by multibeam sonars which give a much higher density of seafloor depth information. For that reason, digital terrain models nowadays form far more realistic representations of the bottom topography and hence the interactions between the substrate and the physical processes become much more accessible. Similarly, pure analogue side scan sonar recordings are slowly set aside by the digital acquisition, resulting in geometrically corrected and geo-referenced very high-resolution (VHR) (up to cm) mosaics of complete research areas. These mosaics do not only reveal the often complex morphology of the seafloor (i.e. ripples, megaripples to sandwaves), but from the acoustic reflectivity, also the intrinsic nature of the surface (i.e. sediment type, density, composition) can be deduced and studied in relation to the morphology. Moreover, the very-high resolution of the imagery enables to study the biological and anthropogenical activity imposed on the seafloor. A new approach is to drape side scan sonar imagery over multibeam data, whereby a VHR, multi-parameter, three dimensional digital terrain model is obtained.

Both methods enable the use of acoustic seafloor classification techniques that can aid in the automatic mapping of seabed characteristics such as sediment type or bedforms. Backscatter values are used to calculate statistical parameters, which allow to differentiate between certain seabed classes. In this way it becomes possible to capture the visual information in a quantitative way, such that different areas and surveys can be compared on a common ground. Multibeam backscatter images have the advantage that the reflectivity values are corrected for depth, recording angle, sound velocity,..., while side scan images have a better resolution and hence can be used to study small details.

Clearly, an integrated side scan sonar / multibeam approach opens new perspectives in the understanding of the seafloor architecture and the physical and biological processes involved. As such, more and more information becomes available that can only be addressed through multidisciplinary research.

Keywords: side scan sonar; multibeam sonar; acoustic seafloor classification; modelling.

Strengthening the co-operation on the protection of the marine environment in the Baltic Sea

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This project intends to strengthen the co-operation between the coastal states in the Baltic Sea on the protection of the marine environment. More specifically, it would be the idea to investigate whether the establishment of 'marine parks' is a useful instrument to develop a common policy and to strengthen the regional co-operation on the protection of the marine environment, in order to increase the chances of rehabilitation of the Baltic Sea.
The concept of marine parks is rather new and quite recently, several international institutions and programmes, such as the International Maritime Organization (IMO), the European Union (EU), the 1982 Law of the Sea Convention (LOSC), the Baltic Environment Protection Commission (HELCOM) and the United Nations Environment Programme (UNEP), have taken some initiatives in this regard. It seems therefore useful to examine together with the two foreign research partners (Queen Mary and Westfield College in London and the University of Uppsala in Sweden) the existing international legal framework and practice in this regard. Quite often different terms are used to describe identical or nearly identical concepts. We refer here for instance to article 211 (6) of the LOSC which envisages the possibility for coastal states to designate in their exclusive economic zone 'clearly defined areas', where additional mandatory measures can be imposed to protect the marine environment. Also the International Convention for the Prevention of Pollution from Ships (MARPOL) provides for the establishment of so-called 'special areas', where more stringent rules than the generally accepted international rules and standards, can be imposed. In addition, IMO introduced in this regard quite recently another concept, namely the so-called 'particularly sensitive sea areas'. The European Union on her part, introduced after the *Braer* incident the concept of 'environmentally sensitive areas'. After having examined and clarified the existing international legal framework, it would be the idea to make a comparative analysis of the state practice in the Baltic Sea in this respect. In order to collect the necessary information, a system of national correspondents in the countries involved, would be set up. The idea is to co-operate therefore during a first phase with the academic world. These so-called national correspondents would commit themselves to provide information on their national legislation with regard to the protection of the marine environment and the establishment of marine parks. The information, obtained from the correspondents by means of a questionnaire, will serve as a basis for the comparative analysis of the state practice, undertaken by a research assistant in co-operation with the foreign research partners. Finally, the results of the comparative scientific study would serve as a basis for the formulation of concrete proposals for possible closer co-operation on the protection of the marine environment in the Baltic Sea by means of the establishment of marine parks.

Molecular diversity and population structure of three different marine benthic taxa in relation to their means of dispersal

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Biodiversity can be studied at several levels from ecosystem-, species-, to population-level. At the population level genetic variation can appear within a species due to mutation, genetic drift, recombination, gene migration and selection, which can cause differences between populations. Gene flow is an important determinant in population genetic structuring and is closely associated with the dispersal capacities of a species, the presence of barriers and historical phenomena. The objective of this research project is a study of the genetic diversity and stucturing of some dominant species-populations of different invertebrate taxa from the North Sea, adjacent North East Atlantic coast and estuaries. Three benthic taxa with different means of mobility were selected for this research: hyperbenthic Mysidacea, meiobenthic Harpacticoida and meiobenthic Nematoda. This research will focus on the link between the gene flow and the different means of dispersal of these three benthic taxa. Within each taxon two species are selected from different habitat types. Different populations will be analysed in order to get insight on the effect of habitat fragmentation on the degree of genetic diversity and structuring.

Within the taxon of the Mysidacea populations of the species *Neomysis integer*, which inhabits discrete estuarine habitats, and *Mesopodopsis slabberi*, which has a more continuous habitat will be investigated and compared. So far the genetic diversity and population genetic structure are analysed by sequencing two different molecular markers: the Internal Transcribed Spacer (ITS), which is a region in the ribosomal DNA between the more conservative 18S and 28S genes, and the cytochrome *b* gene, which is a mitochondrial gene. Four different estuaries (the Wista, Weser, Westerschelde and Gironde) are analysed for the mitochondrial cytochrome *b* gene of *Neomysis integer*. This molecular marker with a length of 419 bp shows a small degree of differentiation between the four estuaries. Especially the Gironde estuary seems to be quite distinct from the 'northern' estuaries (Westerschelde, Weser and Wista). The analysis of the ribosomal ITS1 region of *Neomysis integer* shows more problems than the cytochrome *b* gene. Almost no variation is detected in the preliminary sequence data from six estuaries (Wista, Lake Ferring, Weser, Westerschelde, La Canche, Gironde). This suggests that the ITS1 region of Mysidacea is not so useful in detecting population subdivision and analysing molecular diversity.

Taxonomy, systematics and faunistics of the Holothuroidea from the Western Indian Ocean

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Holothurians, the order of the Aspidochirotida in particular, are collected *en masse* in the littoral waters of the western Indian Ocean. As these unregulated practices result in plummeting stocks, there is an urgent need for appropriate conservation and management plans. However, the problems associated with insufficient, often wrong, taxonomical and systematical documentation, hamper comprehension of the structure, function, history and future of this important biological group.

In depth sampling at two accessible regions (Kenya and KwaZuluNatal, Republic of South Africa) combined with literature surveys (with the help of the Flanders Marine Data and Information Centre) allows us to draw a clearer picture on today's holothurian biodiversity.

As a natural outcome of our taxo-systematical work, we are beginning to find the answers to important biogeographical questions like 'How did the species of the western Indian Ocean get there?'

However, although taxonomy and systematics help us to orden the wealth of different species into an usable system, a complete causal picture cannot be extracted from this work. As a consequence, our future research will be directed at ellucidating the ways of evolution (phylogeny) of the different taxa, both over time and space.

The change in macroalgal assemblages through the Saldanha Bay / Langebaan Lagoon ecosystem (South Africa)

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The intertidal macroalgal assemblages of Saldanha Bay and Langebaan Lagoon were studied in relation to the relatively well known South African West Coast flora. Three distinct floral entities were identified using various analytical techniques: (i) the species poor, though distinct, salt marshes; (ii) the lagoon sites, and (iii) the bay and West Coast sites. The species richness of the bay/West Coast entity is larger than in the lagoon. The change in algal composition can be explained in terms of the environmental variables of which the wave exposure is the most significant one. Biogeographical affinities within the entire South African shoreline were determined for the different algal entities. The bay/West Coast entity harbours a typical West Coast flora, with some noticeable effects of uplift of subtidal species into the infralittoral fringe and morphological variation in less exposed areas. The algal flora of the lagoon is also dominated by West Coast species, but is typified by species characteristic of sheltered habitats, and with a number of species which otherwise only occur on the geographically distant South Coast. The algae from the salt marshes belong to species which occur widely in these sorts of habitats.

Tidal migration of nematodes on an estuarine mudflat (Molenplaat, Schelde Estuary, SW Netherlands)

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The vertical distribution patterns of the nematode community and of the ten most dominant nematode species on an intertidal flat in the Schelde Estuary (Molenplaat, The Netherlands) is described at specific time intervals over a tidal cycle. The observed distribution profiles indicate that vertical migrations occur and are species-specific. These tidal migrations were statistically significant in three species: the predatory *Enoploides longispiculosus* and the deposit-feeding *Daptonema normandicum* migrated upwards at incoming tide and downwards when the flat became exposed, while another deposit feeder, *Daptonema setosum*, did the opposite. Several abiotic and biotic factors may contribute to the observed patterns. Hydrodynamics, pore water drainage and episodic steep increases in temperature upon low tide exposure, as well as vertical movements of prey organisms may have been of particular relevance at the time and site of sampling. However, the impact of each of these factors needs further investigation. The present study corroborates the dynamic nature of vertical distribution profiles of nematodes in intertidal sediments, and demonstrates that vertical migrations are highly species-specific. This highlights the importance of sampling time, with respect to the tide, as well as of a species approach, in vertical distribution studies of nematodes in intertidal sediments.

Tidal marsh sedimentation in the Scheldt estuary: a field and modelling approach

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In the tidal marshes of the Scheldt estuary, deposition of suspended sediment takes place during tidal inundation. Tidal marsh sedimentation has an important effect on the functions of the estuary: (1) it is one of the most important controlling factors for changes in the estuarine ecosystem, (2) it can diminish sedimentation in the stream channel, which has to be maintained for intensive shipping, and (3) it reduces the role of tidal marshes as inundation areas, which can protect inhabited areas from flooding. In this research project, tidal marsh sedimentation is studied on the basis of field measurements and numerical modelling, on different spatial and temporal scales. Depending on the scale, different field methods and modelling approaches are used.

On the small scale, sedimentation patterns are studied with a high spatial and temporal resolution. Field studies are carried out at 3 small study sites (of ca. 30ha). On each study site, sediment deposition is measured at different locations within the marsh, using plastic sediment traps. These are replaced every 15 days after a spring-neap tidal cycle. The data show strong spatial variations, ranging from < 20 to > 1000g/m^2, during one spring-neap cycle. These variations are especially determined by the marsh topography. Young (low lying) marshes have higher sedimentation rates than old (high) marshes, due to higher and more frequent tidal inundations. The distance to the nearest tidal creek or the stream channel of the Scheldt River plays a secondary role on sediment delivery and deposition. Temporal variations between spring-neap cycles are affected by differences in inundation frequency and height. The higher the inundation height, the more suspended sediment is transported to and deposited on the marsh surface.

To model these small scale sedimentation patterns, a two-dimensional modelling approach is followed, which takes into account the complex interactions between marsh surface topography and the flow of water and sediment over the marsh surface. For that we will use two-dimensional finite element models and CFD modelling techniques. Model simulations will then be compared with the field measurements.

Tidal marsh sedimentation is also studied on the large scale. At 15 marsh locations, scattered along the Scheldt estuary, the sedimentation rate during the past 100 years is estimated on the basis of ^{210}Pb-dating of boring samples. Young marshes are characterised by initially high sedimentation rates. After an equilibrium level is attained, the sedimentation rate is much lower and is then expected to be controlled by the increase of mean high water levels and by the suspended sediment characteristics, which vary along the Scheldt estuary.

These large-scale sedimentation patterns can be modelled following a 1-dimensional modelling approach, based on long-term simulation of tidal marsh inundation and the solution of a simple mass balance equation over all these inundations. Preliminary modelling results are in good agreement with observed field data.

Keywords: tidal marshes; sediment deposition; numerical modelling; Scheldt estuary.

Three reasons why morphological models are only useful to extrapolate field data

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Some decades ago, the physics behind mathematical morphological models where very simple, only describing the basic processes. Nowadays these models are very complicated, with a lot of input parameters, and incorporating a lot of physical processes. This gives the impression that these models can correctly estimate morphological changes on beaches, navigation channels, sand banks,... The truth however is that they are even not able to predict correctly the direction of sediment transport if they are not extensively calibrated.

Results of recent detailed measuring campaigns in the Netherlands and the UK were compared with predictions of most of the mathematical models used in Europe (without calibration data). This comparison made clear that a model can be classified as 'good', if the error on sediment transport rate was less than a factor 10, the worst models under- or overestimate the sediment transport rate with a factor 100.

Three possible reasons can be distinguished:

1. Hydrodynamic reasons

The pattern of currents and waves near the beach is extremely complicated. Currents are induced due to the incoming waves: cross-shore undertow, long shore current due to oblique waves, currents due to breaking waves, streaming (near bottom current), rip currents,...
The summation of all these currents will result in a complex 3D flow pattern. If one of the components is modelled incorrectly, the predicted flow pattern might be completely different from the real flow pattern, resulting in a completely wrong sediment transport estimation. Field campaigns made clear that even the most complicated models are unable to correctly reproduce this flow pattern, where the undertow is the most difficult current to model.
Waves break at places which are difficult to predict, the asymmetry of the waves and bond long waves due to wave groupiness can become dominant for the sediment transport rate.

2. Morphological reason

The suspended sediment concentration profile is extremely sensitive to the presence and the dimension of bed forms (ripples). For increasing wave action and currents the ripples become higher and steeper till they become unstable. If the hydrodynamic action still increases the bed will become plain. The higher the ripples, the more sediment can come in suspension. When the ripples become flatter, the concentration will decrease (although hydrodynamic action becomes more intensive). However if the bed is completely flat, sheet flow occurs and the suspended sediment concentrations increase again.
The data used to predict ripple dimensions show a lot of scatter, making it difficult to predict the ripple dimensions. A small error on the ripple dimension will however cause a large error on the suspended sediment concentration profile.

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Small currents superimposed on waves or wave asymmetry might even reverse unexpectedly the direction of sediment transport.

3. Sedimentological reason

Computational Fluid Dynamics (CFD) models show that it is extremely important to describe the grain size distribution in detail. The suspended sediment concentration changes an order of magnitude if only (d50), only (d16, d50 and d86) or (d6, d16, d26, d50 and d86) are incorporated (di the grain size for which i% of the grains is finer). Since it is difficult to receive sedimentological data over the whole project field, field data can help to estimate the optimal grain size to be used in the model to estimate as good as possible the concentration profiles.

On the poster, own work with a CFD-model, and two measuring campaigns in the Delta wave flume and the wave tunnel of Delft Hydraulics will be presented, illustrating the three reasons why a field campaign is indispensable to calibrate morphological models.

Wave run-up and wave overtopping on a rubble mound breakwater

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Many physical processes concerning the land-ocean interaction such as wave run-up and wave overtopping are not yet fully understood. These are very important in the design of the crest height of sloping coastal structures. Nowadays, this design is solely based on small-scale model tests. A clear difference between prototype measurement results and laboratory test results is noticed.

Prototype measurements are carried out at the northern part of the Westdam of the outer harbour of Zeebrugge. The structure is a conventional rubble mound breakwater armoured with 25 ton grooved cubes. The breakwater is fully instrumented for the measurement of the sea state, wave run-up and wave overtopping. On the one hand, wave run-up is measured by a spiderweb system, i.e. a set of seven vertical step gauges placed between the measuring jetty and the armour units, measuring the water surface elevations. Out of these measurements, the wave run-up level is calculated. On the other hand, a run-up gauge placed on top of the armour units detects the wave run-up directly. A good agreement between the results obtained by both measuring devices is found. Behind the crest of the breakwater an overtopping tank of about $28m^3$ is constructed in order to collect the overtopping discharges. A compound weir with a thoroughly investigated cross section controls the outflow of the water. From the measurement of the water level in the tank and the calibration formula of the weir, the overtopping discharge and the volumes of the individual overtopping waves can be calculated.

Up till now, 13 storms (between 28/08/1995 and 23/01/2000) have been observed at the Belgian coastline. The dimensions of the armour units and the attacking significant wave height are of the same order of magnitude.

Three scale models of the Zeebrugge breakwater are built and tested. At Aalborg University (Denmark) a three-dimensional model is built in the wave basin on scale 1:40 and in Flanders Hydraulics (Belgium) and in Universidad Politécnica de Valencia (Spain) a two-dimensional 1:30 scale model is tested in the wave flume. By means of a novel laboratory step gauge, wave run-up levels can be detected more accurately. The distance between the armour units and the electrodes of the step gauge is less than 2mm, whereas in case of a traditional run-up gauge this distance is much larger. The measured prototype storms are reproduced in the laboratories.

Analysis of prototype data, gathered at a two-hour period around high water shows that the dimensionless wave run-up value $\frac{Ru_{2\%}}{H_{mo}}$ equals 1.80. $Ru_{2\%}$ is the wave run-up level exceeded by 2% of the waves and H_{mo} is the significant wave height. When a whole tide cycle is analysed, dimensionless run-up values increase when water depth decreases. At mean tide the dimensionless wave run-up value becomes larger than 2. Wave run-up is Rayleigh distributed. Laboratory experiment results show a clear underestimation of reality: two and three-dimensional testing yield almost the same dimensionless wave run-up value of 1.5 at high water. However, results diverge when water depth decreases. Laboratory tests also show that their results are clearly dependent on the value of the spectral width parameter ε and the placement pattern of the armour units on the one hand and the type and relative position of the measuring devices on the other hand.

These results are obtained through the European Union funded 'OPTICREST'-project. Therefore, the financial support of the EU and the Flemish Community is very much acknowledged.

Macrobenthic communities of the Belgian Continental Shelf: analysis of combined data collected over a six-year period

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Within the frame of different research projects, a large number of stations on the Belgian Continental Shelf (BCS) were sampled for the macrobenthos between 1994 and 2000. These samples cover a diverse range of habitats: from the sandy beaches to the open sea, from the gullies in between sandbanks to the top of the sandbanks, and from coarse sandy to clay sediments. To investigate the large-scale spatial distribution of the macrobenthos of the BCS, the data of all these research projects – 768 sample places in total – were combined and analyzed. By means of several multivariate techniques (Two Way Indicator Species Analysis, Detrended Correspondence Analysis and Cluster analysis), 10 sample groups were distinguished. Each sample group is found in a particular physico-chemical environment and contains a specific set of species.

Four sample groups are differing drastically, both in habitat and species composition, and are considered to represent four macrobenthic communities. A first community, the *Abra alba– Mysella bidentata* community, is found at sites, situated mainly in the gullies of the western Coastal Banks, with fine sandy sediments and relatively high mud contents. The high macrobenthic diversity (N_0: 25 species/sample on average) and densities (5356 ind/m^2 on average) are characteristic for this group. The dominant species are the bivalves *Abra alba, Spisula subtruncata* and *Mysella bidentata,* the polychaetes *Lanice conchilega* and *Sthenelais boa,* and the crustacean *Pariambus typicus*.
The second community, *Nephtys cirrosa* community, is found in stations with medium sandy sediments and a very low mud content. This group is less diverse (N_0: 7 species/sample on average) and the densities are low (402 ind/m^2 on average).

The macrobenthic diversity and densities of the third community, the *Ophelia limacina–Glycera lapidum* community, are very low, respectively 5 species/sample and 180 ind/m^2 on average. This community is found at stations with coarse sandy sediments and is typically situated on the sandbanks further off-shore (Flemish banks, Hinder banks and Zeeland banks).

The fourth community, the *Eurydice pulchra–Scolelepis squamata* community, is exclusively found at the high intertidal sandy beaches and is characterized by a low diversity (N_0: 5 species/sample on average) and high densities (305 ind/m^2 on average). Typical species are the crustaceans *Eurydice pulchra* and *Bathyporeia spp* and the polychaete *Scolelepis squamata*.

Of course these macrobenthic communities are not isolated from each other and five specific transitional species associations were found. The transition between the *Abra alba-Mysella bidentata* and the *Nephtys cirrosa* community is characterized by a decreasing diversity, mainly caused by a decrease in mud content. This transitional species association contains high densities (1263 ind/m^2 on average) of the polychaete *Magelona mirabilis*. The transition between the *Nephtys cirrosa* and the *Ophelia limacina–Glycera lapidum* community is characterized by decreasing densities and coincides with a gradual transition between medium and coarse sandy sediments. From the *Nephtys cirrosa* to the *Eurydice pulchra–Scolelepis squamata* community, transitional species associations, related to the transition from the subtidal to the intertidal environment, were found. No transitional species associations were found between the *Abra alba–Mysella bidentata* and *Ophelia limacina–Glycera lapidum* communities, nor between the *Ophelia limacina–Glycera lapidum* and the *Eurydice pulchra–Scolelepis squamata* communities.

The spatial distribution of the macrobenthos of the BCS is thus characterized by four drastically different communities, 'connected' with each other by means of gradual transitional species associations.

Neogastropods from the southern North Sea: preliminary faunistic results

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Neogastropods from the southern North Sea, from several collections in the RBINS were revised. The bulk of the material belongs to the Gustave Gilson collection, which was sampled between 1898 and 1939. Special attention was given to the samples from the Belgian littoral and offshore zone.

A computer database was developed, documenting the taxonomic, geographic and ecological information. Distribution maps for several species of neogastropods were prepared, using the software program Carto Fauna-Flora.

Results show that seven neogastropod species were recorded alive in the surveyed area between 1899 and 1971: *Nucella lapillus* (Linnaeus, 1758), *Ocenebra erinacea* (Linnaeus, 1758), *Neptunea antiqua* (Linnaeus, 1758), *Buccinum undatum* Linnaeus, 1758, *Nassarius incrassatus* (Ström, 1768), *Nassarius reticulatus* (Linnaeus, 1758) and *Oenopota turricula* (Montagu, 1803). *B. undatum* seems to be the most widely distributed neogastropod. The other neogastropod species in the RBINS collections like *Colus gracilis* (Da Costa, 1778), *Bellaspira rufa* (Montagu, 1803), *Bellaspira septangularis* (Montagu, 1803), *Boreotrophon clathratus* (Linnaeus, 1767), *Boreotrophon truncatus* (Ström, 1768), *Trophonopsis muricatus* (Montagu, 1803) and *Nassarius pygmaeus* (Lamarck, 1822) are represented only by empty shells. Although some have a 'fresh look', most of the shells are subfossil or fossil.

Today, there is no certainty on the conservational status of the neogastropods in Belgium. Literature data indicate that *N. lapillus*, *B. undatum* and *N. reticulatus* have been alive for the past 20 years and that *N. lapillus* is rapidly declining.

Terns in the harbour of Zeebrugge (Belgium)

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The outer harbour of Zeebrugge, located at the east coast of Belgium, is presently the major breeding site of Sandwich *Sterna sandvicensis,* Common S. *hirundo* and Little Tern S. *albifrons* in Belgium.

Several sand suppletions in the early eighties created a vast area (150ha) of flat, suitable land for breeding terns and gulls. As a result of major changes during the process of development of the outer harbour breeding sites changed almost every year and breeding numbers fluctuated a lot.

The breeding population of the three tern species in Zeebrugge is or has been of international importance (1-2% of the total population). Nowadays more than 95% of the Belgian breeding population of Common Tern is situated in Zeebrugge. For Sandwich and Little Tern, Zeebrugge is the only breeding site in Belgium.

The future for nesting terns in Belgium is unsure due to plans for the development of the harbour of Zeebrugge and uncertainties in other newly created or planned areas along the Belgian coast.

Research activities carried out by the Institute of Nature Conservation in the outer harbour of Zeebrugge are described.

Meiobenthos and nematode community diversity patterns on isolated sandbank systems from the Belgian Continental Shelf

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The Belgian Continental Shelf is characterised by the presence of four isolated subtidal sandbank systems (the Coastal Banks, the Flemish Banks, the Hinder Banks and the Zeeland Banks), which increase greatly the habitat heterogeneity of the area. These sandbanks form a geologically unique area and they are important for both marine and seabird life since they act as internationally important resting and foraging areas for various seabird species, feeding on small pelagic fish and macrobenthos. The rich marine and bird life makes them suitable areas for designation as marine protected areas as already recognised in other areas (e.g. the Baltic Sea). Surprisingly, the benthos of the sandbanks systems is poorly investigated. Therefore, all sandbanks belonging to the Flemish Banks, Hinder Banks and Zeeland Banks were visited during spring and fall of 1997 and 1998. Samples for meiobenthos were taken on all sandbanks and for each sandbank system, the nematodes from one sandbank (two sandbanks for the Hinder Bank system) were identified to species level.

On the meiobenthic taxon level, no distinction between the meiobenthos from different sandbanks could be made. Stations originating from one sandbank system or a single sandbank are distributed among different groups when multivariate analyses were performed, reflecting sedimentological diversity on a sandbank rather than geographical position. Meiobenthic taxon diversity and density was highest in sediments with a median grain size of 300-400μm, while coarser sediments showed a similar diversity in lower densities. Both density and diversity was lower when median grains size dropped below 300μm.

When nematode communities were considered, a very different picture emerged. The community composition from four sandbanks, representing three sandbank systems showed major differences. Every sandbank represented one group in multivariate analysis. Moreover, the Kwintebank community was separated in three groups. Here, a channel station was separated from the sandbank itself, the latter group being subdivided in the northern area, where sand extraction occurs regularly and the less influenced southern part. This clear geographical separation of the communities suggests the sandbanks to be isolated 'islands' from the point of view of the nematode communities. This can be explained by water movements around the sandbanks, preventing exchange of species between the sandbanks and sandbank systems.

Generally it can be put forward that sandbanks are clearly different from the surrounding channels, both in terms of densities and diversity. The study of nematode communities clearly revealed the geographical differences between the sandbanks, therefore it is suggested that nematodes should be identified to species level in order to clarify possible differences between sandbanks or sandbank systems.

Applying global mathematical models in the cartography of sandbanks, a case study

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For the mapping of sandbanks we will make use of global mathematical models. The general models available are the trendsurfaces (algebraic) and the double Fourier series (trigonometric). In this case study we will focus on the double Fourier series model.

The justification why to use these models falls within the framework of a general research on the influence of point patterns on different models for the representation of the relief of submarine sandbanks. Our hypothesis states that these global methods are less subject to the influence of certain point patterns with as result that these models can serve as a base for a further mapping. A second justification is that there is always a general trend in the data, which can be described by global models.

The research module now tries to determine to which extent the models can be used for mapping. We look how this global model reacts on different point patterns (orientation, density, track distance) and this in relation to the model settings. In order to compare the different models we developed a testing method, based on general descriptive coefficients, correlation coefficients and graphical techniques. For making these estimates possible we make use of a validation data set.

With an increase of the number of terms, used in the equation, we expect a performance increase. Aside this expected result we also notice an instability effect. This effect can be correlated with the distance between tracks (the data pattern) and the number of terms in the equation. This last variable is related to the wavelengths of the cosine en sine function in the equation.

Furthermore we examine how the model can be applied for mapping the submarine structures and we distinguish between direct mapping and indirect mapping. As an indirect mapping we state that the deviations with respect to the model are significant and thus represent a local component. This interpretation gives us the opportunity to map the differences between the data and the model with local methods, like the classical interpolation models.

The testosterone metabolism of *Neomysis integer*: how different are we from shrimp?

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Alteration of the hormone system through chemicals (endocrine disrupters) has recently become a widely investigated and politically charged issue. Invertebrates account for 95% of the known species of animals on earth, yet surprisingly little effort has been put into understanding their value in signaling potential environmental endocrine disruption. Several indications however exist that chemical pollutants act as endocrine disruptors also in invertebrates.

Both vertebrate and invertebrate species use enzymatic biotransformations for the detoxication and elimination of xenobiotics. Testosterone has been used as a substrate to study the multiplicity of these enzymes. Since many of these enzymes are under hormone control, disruption of the hormone function can lead to potential effects on enzyme function and subsequently steroid homeostasis. The testosterone metabolism has therefore been proposed as a biomarker of exposure to endocrine disrupters.

In the present study, the estuarine crustacean *Neomysis integer* (Crustacea, Mysidacea) was exposed to both testosterone and [^{14}C]-testosterone. Identification and quantification of testosterone metabolites and endogenous vertebrate-type steroids was performed using TLC (Thin Layer Chromatography) and HPLC (High Pressure Liquid Chromatography) methods.

N. integer metabolises testosterone extensively: at least 11 mono-hydroxy metabolites, androstenedione and ß-boldenone (an anabolic steroid, known from veterinary drug preparations and also popular among bodybuilders, was identified for the first time in invertebrates) were detected and quantified. Evidence of a sex-specific metabolisation of testosterone was observed in *N. integer*. Endogenous vertebrate-type steroids were also identified in unexposed organisms and testosterone production was detected for the first time in mysid shrimp.

These new insights show an enzymatic biotransformation ability and steroid metabolism in mysid shrimp that rivals that of vertebrate species. This similarity of enzymatic biotransformation among species underlines the importance of further research on the steroid metabolism in invertebrates and the possible use of these systems as biomarkers for exposure to endocrine disrupters. These results stimulate further research on the use of invertebrates as relevant test species for the effects of endocrine disrupters and could result in the development of predictive biomarkers for detection of endocrine disruption in estuarine environments.

Keywords: testosterone metabolism; *Neomysis integer*; endocrine disruption; invertebrate.

Artificial hard substrata as ecosystems – a case-study of the Belgian coast

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Natural, intertidal hard substrata (rocky shores) are characterized by a high density, and especially a very high diversity of marine organisms (e.g. algae, epilithic invertebrates, fishes and birds). The very high diversity of the complex rocky shore ecosystem results from biological (predation, competition, grazing,...) and non-biological interactions (tides, waves, coast topography,...). The majority of the organisms living on rocky shores is only found in unique species associations. Hence, the ecology of rocky shores differs drastically from the surrounding soft-bottom substrata (e.g. sandy beaches).

In contrast to the northern French coast (Cap Gris Nez and the surroundings), natural hard substrata are not found along the Belgian coast. However, within the framework of coastal defence, lots of artificial hard substrata, like groins, dykes and harbour walls, were built. These artificial hard substrata, on which the typical floristic and faunistic associations of rocky shores can develop, act as a substitute for the natural hard substrata in an originally soft-bottom area. The hard substrata of the Belgian coast thus contribute to an increase of the coastal biological diversity. The ecological importance of the Belgian hard substrata is also demonstrated by the high numbers of Purple Sandpipers (*Calidris maritima*) and Turnstones (*Arenaria interpres*). Nevertheless, the biology of the Belgian artificial hard substrata is hardly known. The few data available are dealing with algae and associated fauna from hard substrata (Coppejans, 1998; Daro, 1969,1970; De Vos, 1980).

To increase the knowledge of this unique ecosystem, an interdisciplinary research project was set up to investigate (1) the biodiversity of the Belgian artificial hard substrata, focussing on macro-algae, macrofauna and avifauna, (2) their seasonal variation and (3) their biological interactions.

First of all the different types of Belgian artificial hard substrata were classified, according to the situation of hard substrate (e.g. dyke or groin) and the composing material (e.g. concrete or natural stone). Each type was sampled for its macro-fauna and -algae by means of approximately 20 samples, using a quadrant (50x50cm) in which the occurrence of all macrofauna and -algae was quantitatively examined. A subsample (10x10cm) was taken to retrieve a semi-quantative estimation of the free-living species (e.g. isopods and amphipods). Additional photographic surveys were used as a control. Next to these data, environmental variables, such as height, exposure, and orientation, were recorded. The distribution of the avifauna was investigated by intensive counts along the whole Belgian coast. In a next phase of the project, this sampling method will be repeated seasonally during one year to study the seasonal variation within the macrofauna, macro-algae and avifauna. Finally, the research project will deal with the ecological interactions between the macro-algae, macrofauna and avifauna. Preliminary results for the macrofauna (6 of the 15 types of hard substrata investigated) will be presented.

Atmospheric particles above the North Sea: new insights using recent technology

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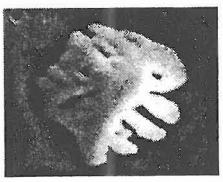

Electron microscopy, combined with electron-induced X-ray spectrometry, is a fast and powerful technique to analyse huge numbers of individual microparticles. Recent developments in X-ray detector technology now have made it possible to detect the signals from elements with low atomic numbers. The determination of these light elements, such as carbon, nitrogen and oxygen, in atmospheric aerosol particles is important to study the chemical behaviour of atmospheric pollution. E.g. the majority of marine nutrients are nitrogen-rich materials: their atmospheric deposition to the sea and the knowledge of their distribution in atmospheric particles could enhance our knowledge on eutrophication and algal bloom. The semi-quantitative determination of light and heavier elements in individual atmospheric particles could give additional and useful chemical information to marine aerosol studies. Their concentrations not only give us molecular information (speciation), but could also result in an enhanced knowledge on their reactivity and transport in the air (going to or coming from the sea).

The electron probe microanalyzer (EPMA) in our research facility has been equipped with a new thin-window detector, which can detect elements starting from carbon (atomic number $Z > 5$). A quantification method based on reverse Monte Carlo calculations, combined with iterative simulations, has been developed in our group. This method was standardised and tested earlier by measurements on single particles with known chemical compositions. The shape and size of the particles, which are important for the simulations, were determined using high-magnification secondary electron images. Elemental concentrations were afterwards calculated, combining the obtained morphological properties with the X-ray spectra taken from each individual particle.

Special care was also taken of beam-sensitive particles, such as ammonium-sulphate and ammonium-nitrate, which were analysed using a liquid-nitrogen-cooled sample stage. These types of particles are very volatile and their structure is unstable under vacuum conditions or electron bombardment, causing evaporation of the irradiated particles. Cooling down the samples with liquid nitrogen drastically reduces the beam damage effect which also opens up new perspectives on the study of volatile particles.

Individual marine aerosol particles collected using a nine-stage Berner cascade impactor were analysed with thin-window EPMA, after which our new quantification method was applied to study the light element content of the particles. Five sets of marine aerosol samples were collected over the North Sea during a cruise of the Belgian oceanographic research vessel Belgica. One aerosol sample was also collected at the Belgian coast at Blankenberge, around 8m above sea level. Preliminary results on these samples (about 5000 particles) show that the new concentration calculation method can be used to study e.g. the

modification of sea-salt particles in the troposphere. For obtaining information on the possible sources of the aerosol and the possible chemical interactions between gaseous and particulate pollutants, the particles were classified into representative groups using the chemical and morphological data obtained with EPMA. The semi-quantitative knowledge of light element concentrations leads to a more relevant particle classification; therefore the possible sources and interactions occurring in the troposphere can be traced by analysis of large numbers of individual particles.